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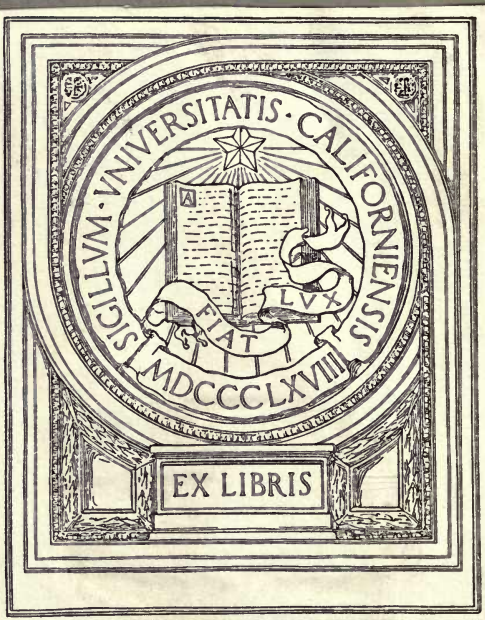
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EVOLUTION OF THE MACHINE SHOP

By

JAMES HARTNESS

JONES & LAMSON MACHINE CO.
SPRINGFIELD, VERMONT
1905

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FOREWORD

THE subject of evolution of the machine shop is treated under three headings :

The first relates to the effect of this evolution on the problems of management ;

The second considers its effect on the interests of the individual workers, and

The third points out in non-technical language some of the changes taking place in the equipment.

Following this will be found the strictly mechanical and commercial descriptions of one of the links in modern equipment.

Throughout the whole it is hoped there will be found a spirit of fairness and exactness of utterance, for it has been our aim to avoid the discourtesy of either making extravagant or superficial statements to readers who are seeking information of a definite character.

MACHINE SHOP MANAGEMENT

IN the good old days of small machine shops and simple mechanism, the problems of management were easily solved. In those days one manager, usually the owner, directed the plant single handed. Now, owing to the greater size of individual plants, the intricacy of both the mechanism and business relations, the work of direction is divided between several managers.

The first and most common division of work separates the mechanical from the financial; after this the subdivisions go on according to the magnitude of the plant.

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The present practice of division of the work has had a tendency to narrow the view and obscure some of the essential conditions that should be constantly borne in mind, and it is our purpose now to call attention to some of these essential elements. They will be unmistakably recognized when separated from their present covering of voluminous data, and this isolation of these facts will make it possible to present to the financier some of the controlling mechanical elements, and to the mechanical manager some of the real essentials of the financial side.

No attempt is to be made to give the financier instruction in finance, our sole aim being to separate the controlling points from the maze of non-essentials, the financial for the mechanical managers and the mechanical for the financier, and as a result bring closely together fundamental mechanical and financial data relating to the machine shop.

Important factors in machine shop management

One of the most important factors to be considered in machine shop management is the plant value. Plant value is sometimes superficially stated to be wholly dependent on the earning power of the plant, although it is not generally stated that it is the *present* earning power that is being used as a basis, yet, nevertheless, this is the actual basis.

Now, since the present earning power may be at the expense of plant value, it is best to get clearly in mind what constitutes genuine plant value, and when it is safe to assume that the plant is not depreciating.

Value based on inventory

The scheme of valuation has for its object the obtaining of some basis for recording its approximate value in financial terms. Valuation based on inventory is made up according to the value of each element.

This valuation should not be considered the real value of the plant in operation. It is only its selling value, not the value at which it should be retained and operated.

To make this statement clearer it is only necessary to imagine an extreme case of a machine shop intended for general machine building purposes, equipped exclusively with lathes of one size and having no other kind of machinery. Now, the selling value of the plant might look well on paper, but it would not express the true value of a live plant. This example shows that the equipment should be a complete and harmonious whole ; but there is still another comparison to bring out another phase.

Let us take for an example, (and it is not difficult to find one), a machine shop in which the modern links in equipment are missing. The equipment may be considered a harmonious whole, yet, on account of its lacking shapers for small planer work, and boring mills for that class of lathe work, it may be utterly valueless as a plant. This does not mean that it has no value in the second-hand market ; it only means that as it is it has no value as a running machine shop.

Values based on earning power

In determining the earning power of a machine shop it is customary to take the net profit resulting from the sale of its product. This method includes the variable element of the product's market. If the product be one of many of the standard machines in which competition has kept down the selling price, there is less chance of error in taking the earning power as the basis of value, but even here it must be borne in mind that during the last twenty years there has been practically a continuous boom. The unprecedented growth of demand for all kinds of machinery has not only brought into existence many new machine shops, but it has also kept profitably employed many other plants that have not kept abreast of the times.

The new plants have been equipped with machinery having much greater efficiency than the equipment of the old plants, and, since the value of a plant depends on its competitive efficiency, the old plant has suffered a great depreciation by the general

advance in which it has not shared. The fact that it has not ceased to run at a profit has been due to the great demand for all kinds of machine work, and not to its being of value as a competitive plant under normal conditions.

Another deceptive factor is the very uneven results temporarily shown by new and old plants. For instance, the old plant makes so much better use of its old machinery which fits its organization that it sometimes makes a better showing than a new plant which is suffering from congestion caused by many undigested improvements; but as time goes on the equipment and organization of the new plant will become synchronized, and its output will slowly but surely exceed that of the older plant.

Reference has been made to extreme cases, not because such are commonly found, but because they serve as pointers in considering the average plant in which there are frequently found some of the

elements of the extreme; also to bring out the fact that value based on inventory as it is usually taken, and on earning power, may not indicate the true value of the plant.

Elements of plant value

The plant value depends primarily on the efficiency of its various elements. The first may be considered the relation under which its various managers work. Under the head of managers we include all thoughtful workers in the organization.

SANE ORGANIZATION

HARMONY in organization is something that will make success against many adverse conditions, and the lack of it will generally insure defeat, regardless of all other conditions. The thoughtful work of each man is the real progressive work, and, although this is stimulated by a wholesome rivalry, it is wholly checked by strife. Every man knows that an unpleasant controversy in the morning will cut out all

chance of progressive work during the day, and that it is more fatiguing than work.

The absolute necessity of harmonious relation of various managers should not require special mention. It is only stated here because it is of first importance in the element of plant value. It does not appear in the statement of assets of a company, but it must be remembered that no estimate of the plant value can be used as a basis of calculation for the future that does not include this element of supreme importance.

CHANGING CHARACTER OF EQUIPMENT

WE should consider a plant as a living, growing thing, ever changing for better or worse. It must not only be considered from a standpoint of present efficiency when compared with other plants, but its growth in efficiency must be keeping pace with the general progress. Slow growth, due to over-conservatism or lack of courage, may result in a serious loss of

relative position; and, on the other hand, the forced growth sometimes causes a temporary discomfiture, due to failure of organization to adapt itself to the new conditions.

HOW TO MAINTAIN EFFICIENCY

ALTHOUGH the efficiency of the plant as a whole makes the real value, it becomes necessary to consider the elements of its equipment when we wish to find the proper places for pruning and cultivation. Each process and each machine should be compared with the best obtainable to-day for the particular work. This does not mean the latest, but it does mean the best for the work as it comes in this plant to-day and with some view of its probable nature to-morrow.

A machine may be of any age so long as it is the most efficient for the work required of it. But, just as a plant may pass from a state of value to one of no value as a plant, so an individual machine may lose its real value for a given class of work. This

transition from value to no value is generally due to the particular machine having been superseded by something of much greater efficiency. This may occur one year or thirty years after it has been installed.

The process, then, of keeping a plant in permanently profitable condition requires the substitution of the efficient for the inefficient, and the natural place to begin is in that class of machinery in which the greatest difference exists between the best obtainable and that in use.

If the recent progress has been made in planing machines, and the greatest saving can be effected by changes in the planer department, then let the progressive work take place there. If, on the other hand, no great advancement has been recently made in this art, but has been in machines for lathe work, then, let the old planers run, and get the saving by correcting the lathe methods.

THE COST OF PROGRESS

THE cost of new machinery to be put in each year cannot be stated in figures of per centage to total equipment, for it depends on the opportunities and necessities involved in the natural progress of the art. This cost at times adds no burden to the cost of running for the year, for in some instances the saving effected during the year is greater than the first cost of installation, so that the real cost for introduction of some later-day machines may be counted only as time and mental energy involved in carefully considering the problem.

PROBLEMS READILY UNDERSTOOD

IN some of the discussion which follows it is necessary to deal with the strictly mechanical, but it will be done in such a manner that, barring a few paragraphs, every one may clearly understand the governing principles which will serve as pointers in considering many of the

processes involved in present machine shop practice, for, although many marvelous and intricate machines are now in use which are thoroughly understood by only a few men, the art has not yet advanced so far that its fundamental principles are beyond the comprehension of the business man or financier. We do not mean that we may not be bewildered by a sleight-o'-hand performer who directs attention to some insignificant act with one hand while he is performing the real act with the other hand, but we mean that in the discussion that follows the bottom principles will be set forth without reference to the number of teeth in each gear or any other mass of details that has no bearing on the essential facts.

THE PERSONAL VIEW

UNDER this heading we wish to bring out the effect of the evolution on the interest of the individual—not as an owner, but as an earner of a salary or wage: First by stating the real value of an earning power of an individual; then by indicating its relative permanency and means for its protection and betterment.

The salary or pay received in return for services has a greater significance than a mere exchange of money for brain energy. It is an indisputable tribute to the genuine worth of the individual. This is valued by every intelligent worker regardless of his wealth, for, although tribute is sometimes falsely given in words, it is seldom falsely paid in cash.

The value of this remuneration as an evidence of real worth is not all, for it has a monetary value which should not be disregarded. On a 4 per cent. interest earning basis each $100 earned per year indicates

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a value of $2500; hence $1000 earned per year is worth $25,000, and $2000 per year is worth $50,000 to the recipient.

This is real value, with a security in some respects better than a more easily negotiable principal which the possessor might be beguiled into exchanging for some hazardous investment. Since this earning power has this value, let us see on what basis it stands. Is it secure regardless of the possessor's indifference? Or, is it something to be guarded?

Success in management of a business or department may give a good name and a good professional standing, but it must be remembered that just as a plant may or may not be on a sure footing, so there may be a doubt regarding the professional standing and good name of each individual in responsible position.

To-day's standing is based on yesterday's action, and to-morrow's position will be the result of the decisions of to-day.

The correct course for to-day may not be

very clear, but it is safe to conclude that there is no safety in standing still, for that surely results in losing one's position in the race.

One way to make or protect a good name is to be on the right side of questions relating to progressive development. No credit or good comes from weakly suggesting the adoption of this or that method, or resorting to the " I-told-you-so " attitude.

Real results come from strenuous and tireless insistence upon an action which you believe is best.

It may be that the plant will be carried along by the combined work of all without it becoming necessary for you to conspicuously push for some reform, and, as a result of such combined work, the whole scheme may for many years continue to furnish comfortable conditions for you, or, if not, perhaps some other opening may be found in some other establishment, and all this may happen without your playing the painful part of a reformer ; but the chances are

that inaction now will not result in any such favorable future; on the contrary, there is much evidence to show that individuals rise and fall even quicker than companies.

Many of the important actions may be tested without greatly jeopardizing an individual's name; for instance, a maker of a device or machine may make a claim that he can effect an important saving in the cost of your work, and stands ready to demonstrate, without cost to your company, and without placing you on record as indorsing his views—there is small chance of mistake. Let him demonstrate or fail, and let him abide by the result. It is his own proposition. You will indorse it if it is a success, but if it is not, you will not want that machine standing in your plant, for it would be there as a continual evidence of somebody's blunder.

With the ever-increasing complexity of machines you should compare results, and should not hesitate to disclaim attempting to comprehend each minute detail of each

machine. Therefore, let the burden of proof rest on the advocate.

In considering cost of production by present method compared with some newly proposed scheme, see what saving is to be made by the change. The saving for one year makes a convenient basis; compare this with the cost involved in making the change. If you see a chance to make a good saving by the introduction of a certain machine, the next step is to make sure that that machine is the best of its kind.

Unfortunately the maker's standing is not a conclusive proof, for the best machine shop equipment cannot be obtained from any one company or any one section of our country. The best companies are unable to keep their entire line of manufacture in the lead; in fact, some of the machines turned out by the best builders are known to be back numbers. Why is this so? How can they be of the best. and yet so far behind in some respects?

There may be no satisfactory explanation, further than that good things may grow up anywhere in the country and be developed by the most faithful and zealous specialists, and that no one company, no state, and no section of our glorious country, can have a monopoly of all of the machines of all types.

But, while warning against the mistake of selecting a machine on the builder's general reputation, it should be borne in mind that although that is not a guarantee of correct design, the greatest mistake of all is to disregard the builder's reputation.

See to it that your proposed new machinery is of correct design and made by one of the best companies, but don't accept any machine that meets only one of these two requirements.

Whatever policy you follow in the management of your own personal interests, it is safe to state that a careful consideration of each new phase of problems is absolutely necessary to enable you to hold your own, to say nothing about advancement.

The problems of machine shop management are affected by the evolution of its machinery as much, if not more, than by any other element.

All new growth is not of a kind that may be of service to you; in fact, much that is new is inferior to the old.

In this book is set forth a machine built on new lines. It is one of the new things that affects machine shop values. If it is a good machine, it gives its users an advantage over others. If it is not a good machine, the advantage goes to the non-users.

It has been on the market in its present form since March of 1904. It is an outgrowth of the original Flat Turret which held undisputed supremacy since 1891. There are thousands of the original and hundreds of the present in operation. The original machine has been abandoned by its makers for this new type. This may only indicate that they consider the new more profitable; but even so, a machine cannot be profitable to the builder without

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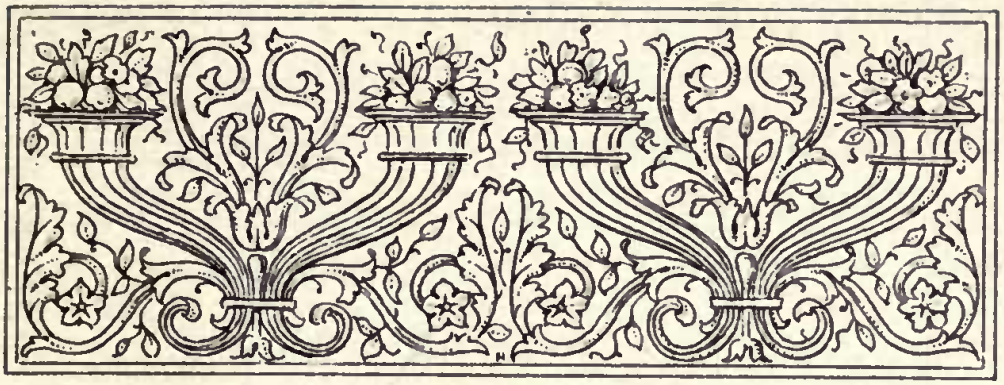
its being in good demand and receiving the hearty indorsement of the users.

In addition to your being able to see a plant exclusively devoted to it manufacture, (and many of the machines may be seen in actual use in other plants), you have in this problem that extra chance of proof offered by the builder to demonstrate its value on your own work, in your own plant, in the hands of your own men, without cost to you, and without your indorsement until it has there shown its value.

The foregoing pointers do not include an important element, and one that must be settled by your own decision; namely, Is this machine the best of its kind? There may be a dozen machines that would effect a saving on some of your work, but in making each move see to it that it is the best. Your own future depends on your judgment in such matters.

In the following pages you will find some of the important points to be kept in mind in considering such questions.



THE evolution of the machine shop is a topic of vital interest to everybody, from the proprietor to the apprentice. All must know the tendency of the times. The development is going on irresistibly. The change affects the security of investment, the reputation of managers and the trade of machinists.

It is a time for cool observation and careful determination of the proper course. There is no other way to protect a good name, to make a good record, or to keep a plant from depreciating, to say nothing about making a dollars-and-cents profit, which is the substantial proof of good work.

The condition that confronts us to-day is one of unusual activity in the development of important changes in the art. There have been whole centuries since the beginning of the human race in which there has been little or no progress in the arts. But the last century was not one of that kind, and the last decade was probably the greatest in point of progressive development, the machine shop sharing in record-making advancement; but great as this advancement has been, there is evidence in the signs of the times that the next five years will greatly outdo the last ten in changing the methods of machine shop work.

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An indication of the tendency of the times may be best obtained by a careful study of the present-day conditions and a glance at the older practice. Within the last ten years many special machines have become standard, and there are now many machines for the work for which there were formerly only the lathe, planer and drill

press; so that the machine shop of to-day does not resemble the machine shop of ten years ago, and it is very safe to assume that the shop of ten years hence will be very unlike the present.

Many of the present-day machines were originally designed for special conditions and for a certain narrow field of work in which good results were given. Nearly all of these machines have been used beyond the field for which they were intended, so that now we find certain parts of the work covered by many different types of machines.

Sufficient data now at hand

This variety renders it possible for the careful observer to select the machines best suited for the present-day conditions, and although this is the process of selection that has been followed in the past, there is to-day not only greater opportunity, but an absolute necessity of knowing the machines that should be used, also those which should be discarded. The machines and methods for next month's work or next year's work should

be selected after carefully looking over those now in use. This may seem a very great task to men who have made a life study of some other phase of work in which every minute of every day is occupied, but it is not so difficult, after all, if the real essentials alone are considered.

Only the real essential elements necessary

It is here the intention to state some of the real essential elements that should be borne in mind by one trying to find the true course. These pointers are all submitted subject to the approval of the reader, and are only offered on their face value, as they may appear to be in accordance with experience and facts within the knowledge of everybody.

It is not necessary to thoroughly understand all of the new special machines put on the market any more than it is necessary to read all of the books of fiction that are now being printed faster than any person living can digest.

A watch may be judged by its record as a timekeeper without much knowledge

of its parts, and although this is true of all machinery there is a certain general knowledge that should be possessed by all who wish to see the direction of evolution.

Now, since so much is written of an advertising nature, in which the real object of the writer is concealed, it is understood that the average reader has become wary, and discounts in advance any statement with the feeling that the writer has his own interest in mind, and that sooner or later it will appear. In the discussion of this subject, however, it is not the intention to conceal this fact, but this very point is brought forward at this time with the acknowledgment that it is a handicap, but with the claim that mechanical facts are hard facts, and that by a full and complete disclosure the subject becomes clear, and that as we proceed each point will be clearly stated that it may be recognized as true or false. No attempt in dealing with hard facts will be made to prove that two and two make five; each proposition is to be of

Mechanical facts susceptible of proof

the simplest nature, and as readily understood as the simplest example in arithmetic, and as definitely conclusive.

In getting at the present conditions in the machine shop always have in mind the useful efficiency of the machine. This means more than the record time in which a piece of work can be machined; it includes the performance of the machine every day in the year.

No profit in record spurts

Many record-making machines have two kinds of records: the number of seconds in which a single piece of work can be machined, and the number of months required to get new tools for each new piece of work. This makes it necessary to observe all of the actual conditions. The standard engine lathe has the good record for continuous work. A glance through any machine shop will usually show all of the lathes at work, but seldom all of the wonder-working special machines in operation.

Many of the most successful machine shop managers have preferred the slow but sure method of getting out the work, and their good results have furnished ample proof of their wisdom; but, as stated in the beginning, this is the period in the evolution of the machine shop in which progressive steps are necessary. Not all of the latter-day machines are found lacking in quick adaptability. Some of these machines will be found in operation every hour of every day, regardless of the character of the work.

Machine for every hour of every day

One of the conditions that should be borne in mind in trying to determine the line of development of the modern machine shop is the changing character of its own work. Many of the rim-rolling and other special machines for bicycle work are of very little use to-day. If there is any evidence that the turbine engine and the electric motor are to partly or wholly displace the present engine and locomotive, those interested should see that their machine shop

Changing character of work

equipment is kept flexible and adaptable enough to meet the new conditions.

The probability of changes

The extreme cases of the bicycle, the turbine engine and the electric motor are not analogous to the changing character of work in the average machine shop, but every one knows that only the most visionary are unmindful of change required in their own product.

It is the intention here to discuss only one of the phases of the subject, but the principles set forth will be found applicable to a wide range.

In order to mention exact conditions we shall consider the lathe and various machines in which a cutting tool is held and controlled by one part of the machine, while the work is held and controlled by another part, the whole object of these machines being to absolutely control the relative motion of work and cutting tool.

So much attention is being given to the convenience of handling in hand-operated machine tools and the development of

automatic features, that we have temporarily lost sight of the greatest of all questions; and that is, the control under which the work and tool are brought together.

Get back to fundamental principles

We know that a cutting tool will last almost indefinitely under some conditions, and under other conditions the edge seems quickly destroyed.

The destruction of the cutting edge is not wholly due to the real work of separating material; in fact, only a small amount of wear is due to the work. The greatest edge-destroying action is side motion or quivering, which in the most extreme cases may be heard and felt.

It has been generally assumed that in absence of any marked quivering, such as would be called chattering, that the tool was free from this edge-destroying action. That this is erroneous will be clearly shown later on.

Very few of the standard machine tools hold the work and tool with sufficient firmness of control to prevent this lateral trembling

or quivering. Before passing this point, it should be explained that the meaning of lateral motion is that motion which is across the cutting edge of the tool, and not in the general direction of the cut.

A cutting edge must be acute, a scraping edge blunt

The cutting edge of a knife would not last long if used for scraping the surface of a stick; in fact, it would not last long if we were to use the knife in the same way that we use a lathe tool in the average lathe. But the knife edge will last in whittling because there is no scrape across its edge. This is just as true of a cutting tool working in metal, for the lateral motion of the metal across the edge of the tool causes a side pressure against the edge where there is no backing, and causes its wearing away, whereas, when the work is moved against the edge firmly in its true path only, the edge is free from side thrust. For the real work of cutting, the extreme edge is braced and sustained by the backing, and has great durability.

Real cutting without quiver sharpens tool

Under correct conditions, the action of a heavy chip of steel on a properly pro-

portioned tool occasionally wears a slight hollow just back of the edge instead of wearing away the edge. This action has been occasionally observed in the engine lathe, where it happens as a result of a balance of conditions which includes an amount of clearance of the tool that just equals the feed, and which allows the tool to steady itself by riding on the finished surface. This prevents the quivering which would otherwise have rounded the edge before the chip could have had time to make an impression elsewhere.

Experience has demonstrated that accurate control of work and tools not only adds to the durability of the tool and accuracy of the product, but this condition makes it possible to leave not only a true surface, but a smooth surface when taking a relatively large cut.

Theory and practice

Now, this is not a point at which to throw down the book and say that this is theory, that the finishing cut must be a light cut, and that the writer is now leaving the

bounds of reason and practice. Experience with the former types of lathes has proven that finishing cuts must be light cuts, or, in other words, a cut that is lighter than the heaviest cut that we can take with the same machine.

Now, this statement is true, although the light cut for the ideal machine would be considered a heavy cut in the old machine, for in the ideal machine both the roughing cut and the finishing cut should be larger than the respective cuts in the former types of machines; the only practical limitation should be in that class of work where, owing to the distortion of the metal on removing a large proportion of its surface, it is necessary to take a light cut for finishing.

Firm control and sharp tools

Firm control makes it possible to use sharp cutting tools; that is, tools with slight clearance and plenty of rake, the rake being principally in the direction to make easy the flow of the metal from the largest part of the chip. This tool, when used without

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back rests, should have the corner slightly rounded, and the part of the tool that leaves the final surface should have sufficient width to cover two or more times the width of the feed, and the proper shape to gradually reduce the thickness of chip as it approaches the finishing part.

We all know the shape of the ideal tool for removing plenty of metal, and at the same time leaving a smooth metal surface.

We have all seen the other extreme where a blunt tool has been made to tear off metal in a powerful machine, in which the finished surface looked as if the metal had been pulled out by the roots.

Rough surface left by powerful machines using blunt tools

Former practice seemed to establish that a comparatively blunt tool should be used in taking a heavy cut. Since this point is more fully explained further on, it is only necessary here to say that the blunt tool is undoubtedly the best for the machines in which it is used, on account of the excessive side quivering, which would

quickly destroy the edge of a properly shaped cutting tool.

Other tool shapes are more fully discussed elsewhere; in order to bring out the importance of correct design in the machine we are here considering only those tools that must depend on the firmness of control of the machine without aid of back rests or steady rests.

The standard lathe

For the purpose of setting forth the common method of controlling both the work and tools, it is necessary to call attention to the present scheme of work and tool carriages. In doing so it will be necessary to say some unkind things about everybody's friend, the standard engine lathe; not that it is the standard engine lathe alone that is borne in mind, for remarks regarding this machine may be readily applied to other tool mountings. We recognize that the engine lathe has been the machine from which all of the wonderful mechanism of the age has come, and although in some respects it is felt that there are other machines of

higher development, there is no machine designer so near the top of the ladder at present that he has any occasion to "holler for more ladder."

Long-distance control

From the time of the birth of the slide-rest lathe it has been customary to have the head stock rigidly affixed to or a part of the bed, and to get all of the relative motion between work and tool by mounting the cutting tool on the necessary slides. The first slide resting on the lathe bed is called the carriage. To the saddle of this carriage there is a tool-carrying slide which runs transversely to the travel of the carriage. In addition to this, it is frequently the practice to add a swiveling slide for traveling at any desired angle, which has been called the compound rest. More than one-third of the lathes used to-day are provided with the three slides.

A glance at the engine lathe carriage shows it to be of frail design. The guiding V's of the bed, on which it rides and by which it is controlled, are a long distance

from the point of the tool. The average carriage has four bearings on the shears. The front part of the carriage consists of a bridge which spans the distance between the two bearings on the front V. In the same way there is a bridge at the back that connects the two contacts on the back V. Now, from these bridges on the front and back V's another bridge runs across, making the whole form in the shape of an H. This may seem an elementary description to the average lathe hand, but the object will appear later on.

Cob-house design of slide upon slide

There are other types of carriage saddles. The H-shaped are most reliable for very light cuts, and others, although uncertain in action in all cuts, are generally better for heavy stock-reducing operations.

There is no opportunity to make either the carriage or the tool mounted thereon of sufficient rigidity to withstand the working strains, nor of suitable section to properly hold their gibbing, which of course serves

as a means of holding each slide to the surface on which it travels.

We will assume that the bed of the standard engine lathe is all that it should be. We know that a single slide can be stiffly designed and securely gibbed to a piece having dimensions similar to the engine lathe bed; that the limitations and troubles come in when it is necessary to cut away that slide, giving clearance here and there for the swing of a pulley or a large shaft and the addition of other slides, all of which must come within certain dimensions, regardless of the effect upon the stiffness.

The natural process of reasoning for the reader at this point is that inasmuch as attention has been directed to these weaknesses, it is merely for the purpose of introducing a machine in which these weaknesses do not exist. There is, however, a more important point to be brought to view. It is that the engine lathe, with this great handicap, is the very machine with which we have obtained our experiences

and formed our opinions regarding the limitations of a cutting tool and the quality of work obtainable under the various cuts.

Increasing dimensions do not compensate for indirect design

No conception of the performance of a tool under heavy cut in a properly proportioned machine can be obtained by the performance of a tool in the engine lathe large enough to take a similar cut. The engine lathe takes its largest cut on work about one-third of its swing, and instead of the tool being controlled by guiding surfaces close to its maximum diameter of most efficient work, these guiding surfaces are three times as far off in a direct line, and many times farther off in the line followed by the metal supporting the tool.

The extent of vibration of the tool point of lateral yielding is governed, of course, by the stiffness of the carriage to resist the working strains at that point, and as this stiffness is inversely as the square of the distance between the sliding base and the cutting tool point, it becomes apparent that

a tool working at this handicap may be forced to crowd off the metal, but while doing so the cutting edge vibrates laterally, making it necessary to use only blunt tools, which add greatly to the "pulling-out-by-the-root" process of removing the metal, and although such lathes can be forced to push off the metal, there is an absence of the cutting action that leaves a true and smooth surface. Furthermore, such lathes are very susceptible to chatter when taking light cuts such as a scraping broad tool, because a certain amount of pressure is required to take up all the slack of their parts and the spring due to long-distance control. This is not a case where the doctors disagree. Lathes are built by people who understand the work thoroughly, but they are built to supply a certain demand that calls for a standard lathe known to every machinist, and it is necessary in offering these lathes for sale to give swing over both shears and carriage, and price.

Diameter of dolls not up to standard

It is apparent that the machine must be made to swing, say, 18 inches, for it is the custom to consider these dimensions in considering the price. They are therefore selling dimensions and must not be reduced. Just as dolls are sold by the length, and when carried home will be found to lack the proportions of the real baby, just so lathes are sold by dimensions that would be deceptive if this were a new subject. As it is, the machinist knows that he must have an 18-inch lathe to do lathe work on a 5-inch or 6-inch shaft.

Many good results have been obtained in special forms of lathes for a given class of work that we are now to take as object lessons, and which may serve as pointers to indicate the direction of the development in machine shop evolution.

Long-distance control, cob-house design, gibs and gib screws without tension, except when taking working strains, any one or all of these are bad conditions. It is not enough to know that the tool mounting is capable of withstanding heaviest cutting

strains without breakage or even perceptible quiver. We must know that the controlling carriages are short, compact and unaffected by strains varying from light to heavy cuts. A tree may be capable of withstanding a hurricane and yet be waved by a light breeze. A child can deflect a wagon spring. Tool holders and carriages are nothing more nor less than springs in equilibrium and should be of the shortest, stiffest possible design.

Breeze sways the tree that withstood a hurricane

In view of the foregoing, it would be safe to assume that the correct scheme is one that gets around the long-distance control and cob-house construction of slide on slide. The foregoing is offered as one of these propositions no deeper to solve and having no more indefinite conclusion than the two and two example in arithmetic mentioned in the beginning. It is needless to say that a machine approaching the ideal is fully described in the strictly commercial part of this book. Each feature of this machine may be readily understood.

The machine set forth gives a control of work and tool that greatly reduces the tendency to chatter, and thereby makes possible the use of ideal tools for all cuts. Sharper tools with plenty of rake for cutting the metal may be used, also broader tools for light and heavy cuts where chattering has been the limiting element.

Stock reducing only one-half of the problem

We are fully aware that it is useless to make a machine with solely large stock-reducing qualities; that although this is almost a supreme test, yet since it is so general to consider cost of metal as well as labor, the average work requires mostly accurate turning at medium chips, and the stock-reducing feat is to be performed only in extreme cases. But it seems to be clear that accurate work requires a machine in which a light broad cut or a heavy stock-removing cut can be taken with the minimum chatter.

The boy and the cane

Chattering is caused by conditions that are fundamentally objectionable. Every boy

knows that he can make a cane chatter along the sidewalk by pushing it ahead at a given angle, and that it will not chatter when dragged at same or any other angle.

The draw-cut shaper astonished many by its wonderful performances of great stock-removing feats, and although this may not be what is primarily wanted in a shaper, it may be cited as an example of the performance of a cutting tool under a pulling cut and non-chattering conditions.

In the lathe, planer, standard shaper and boring mill there seems to be good reason for using the tool mounting that is equivalent to the chattering cane. The expression, "cart before the horse," fits the case, but the plow before the horse would be a better analogy.

Chattering tendency remains

In order to offset the chattering tendency in machine tools of thirty years ago, a spring tool was used for finishing cuts which required a tool having plenty of rake. Under the varying strains this tool would yield in opposite direction to its frail mounting; that is, it would spring away from the

work under an increased strain, while the slide rests had a tendency to tip over towards the work, which would otherwise cause the tool to "duck in." The yielding of the tool would offset the chattering tendency.

This tendency to chatter has been partly met in present-day machines by making all these slides of stiffest form possible, so that it is no longer necessary to use the old-fashioned spring tool. But the fact remains, that although we have greatly reduced the chattering, we have yet the plow before the horse and the cane ahead of the boy; that is, the tendency remains, and the conditions exist to a sufficient extent to necessitate the use of blunt tools for heavy chips, and to greatly restrict the use of broad tools for forming, taper and irregular cuts.

The detailed description and illustrations of the machine described clearly bear evidence of a more perfect control, which is the result of a very low swing, and an absence of long-distance control and slide on slide tool mounting.

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Inasmuch as the dimensions of work affect the design of machine, that is, a planer must be used for long work, while the shaper is best for short work, from here on we will limit our discussion to the work under 12 inches and 14 inches in diameter, for which the two machines described in this book are built.

We will take it for granted that the description of the flat turret which is mounted on our tool slide or carriage, with all its schemes of accurate gibbing and accurate presentation of six different tools at the will of the operator, is all clearly set forth and accepted as the best known means for this purpose, and we will pass at once to the consideration of the mounting of the head stock, which carries the work-holding spindle. Of course, any effort to control the tool slide would be futile if we were to mount the work in a light spindle or in a long overhanging chuck. For this reason it has been necessary to depart from the usual proportions of lathes.

Proportion of spindle to swing

For instance, in these machines the swing is only three and three and one-half times the diameter of the spindle.

The mere statement of these proportions convinces the average man that here is something unusual, and that it is quite likely that a machine having corresponding proportions will be found capable of taking its heaviest cut at its maximum swing, and that the work will be most rigidly held by such a spindle. The details of the construction are clearly set forth in the latter part of this book; and it is only the intention here to consider the principles involved in the adoption of this scheme of work and tool control.

Head stock with cross travel

In order to get away from the cob-house scheme of design of slide on slide for the tool carriage, in this machine we mount the head stock on guideways running across the machine. In this scheme, of course, the head is gibbed directly to the bed, and since there are no additional slides to consider, it is possible, the same as in the case

of the carriage, to adopt an ideal system of gibbing and the stiffest possible design of frame, so that here we have a slide of any desirable shape gibbed directly to the bed.

In passing, an important detail in construction, which is also described elsewhere, is our scheme of gibbing, which puts the gib and its thrust-taking screws under severe tension, even when adjusted for the free movement of the slide. The object is to see that all of the spring of the bolt and gib is taken up before the strain of the work comes on it, and although this is only a detail, it is one of the one hundred or more points on which the success of a machine of this kind stands.

Return of head to central position

The conservative man frequently asks: How is it possible to return this head to its central position? It is only necessary for us to call attention to the fact that for years we have been turning the turret around to six different positions with a satisfactory accuracy, under conditions more difficult to control than the present single direct slide;

and to furthermore state that we not only bring this cross slide with accuracy to its central position, but by an ideal scheme of stops it is possible to bring it to as many other positions as called for by the work with the same nicety, and that these details are elsewhere described.

Just as our experience with the cutting tool in the engine lathe shapes our views of its endurance and capacity for doing good work under heavy cuts, just so our experience with former types of special machines comes to mind whenever a machine of this kind is to be considered. We know that a special machine usually requires special tools, and although this is not apparently a serious objection, owing to our usual hopefulness that there will be no immediate change in the kind of work we are to do, yet even with no change of work in view, the question of special tools, both from the side of expense and delay, is a serious barrier to the adoption of many of the special lathes that are now offered, and it is

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no uncommon experience to find a machine standing two or three months waiting for some special tools for a given piece of work, and frequently a very slight change in the character of the work makes it necessary to throw away or set aside all of the tools in such a machine's equipment. The practical man, therefore, is ready to admit all the theorist may say regarding firmness of control, ideal conditions of slides and anti-cob-house construction, but he will say: "Deliver me from the toils of such a tempter; I have not lived to this point in vain, and I cannot forget my experience with special machines."

Long delays required by special tools

The machine described on pages following page 69 is provided with an equipment of standard tools which it holds under absolute control, conveniently and quickly adjusted, and it puts an end to the foreman's difficulties in getting out the class of work coming within its range, regardless of any changes that may be made in the design or the number of

The "any" machine

pieces to be made; and it is safely described as the "any" machine; that is, it is ready *any* hour of *any* day to make *any* piece of *any* shape and *any* quantity coming within its working dimensions, with an accuracy and efficiency never before attained. This adaptability to all conditions not only gives a ready relief for the troubles of to-day but it also makes progressive designing possible.

Many important improvements in your product can be made without delay or expense if your machines are truly ready for turning every conceivable piece.

The description of the details of the machine which follows renders it possible to understand the various features of the machine. If it has been made clear that this machine indicates the direction in which the evolution of the lathe is traveling, there is no one, from the proprietor to the machinist, who can afford to be indifferent to the subject.

It is not safe for us to disregard important pointers of this character; and there

can be little profit or benefit accruing to any one knowing these facts who fails to act accordingly. The foreman should strenuously advocate what he knows to be true. The superintendent's reputation suffers if he does not advise on correct lines, and the proprietor's profits, to say nothing about the depreciation of his permanent investment, will seriously suffer if he continues to use inferior machines. It is not enough to know that machines in operation were built yesterday; it must be known that they are of the correct type, for with so many machines offered for a given class of work, each machine cannot be the best; some one is better than all the others. Many companies may be wrecked in the future by conditions outside of their control, but we know that the companies that will survive will be only those that take advantage of cost-reducing methods, and that others, instead of being a source of income to the proprietors, will become white elephants, positive burdens that no one can afford to own.

Your success depends

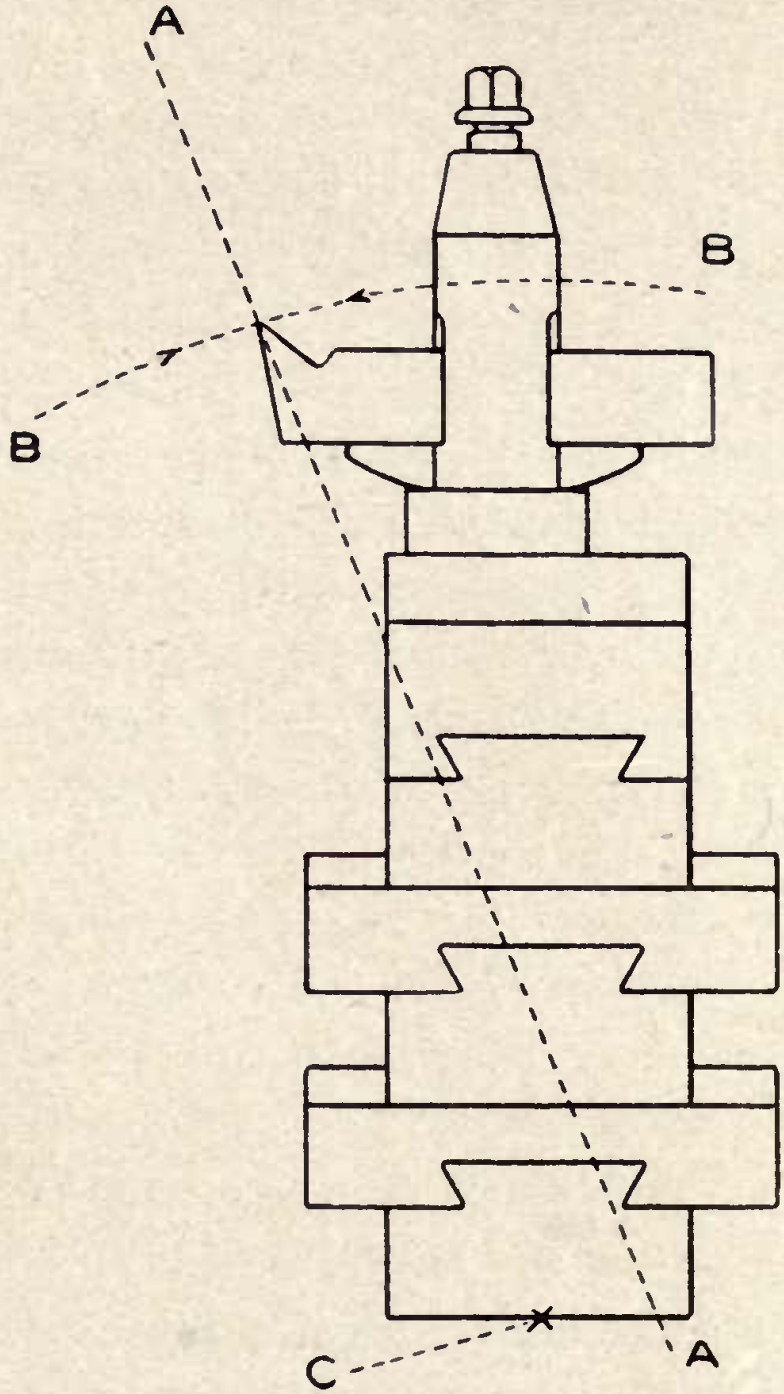
It is not within the scope of this chapter to answer all of the questions that will come to the mind of the man who has given this matter much serious thought and has heard claims for the old type reiterated. Each important point will be fully treated in the most fitting place. The foregoing pages present only a few of the many indications of direction of the evolution of the machine shop. A few more pointers will be found throughout the entire book, including that portion devoted to the commercial description of the machine. Therefore, you are urged to read all of the following pages.

DIAGRAMS ILLUSTRATING CUTTING ACTION

THE cutting strain should be only in line with dotted line *A* to *A* in diagram on following page, which would keep a continuous strain on the cob-house, holding it away from the work, thus taking up all the slack and spring in one direction.

But the real facts of the case are that the tool must be very blunt and very unlike the tool shown in order to maintain a constant thrust. On steel work of small diameter the tool may be set a trifle above the center to maintain a constant backward thrust. The most trouble is experienced in working brass and other soft compositions. For such work it is very common to find tools without top rake. The edge-destroying motion is in line with dotted line *B–B* which is an arc struck from center of base at *C*.

Experience has demonstrated that the tool shown by Fig. 1 is the most effective in many lathes. The reason is that although



Exaggerated Cases of Cob-house Construction, Slide upon Slide

there is a cutting strain of the chip in direction of arrow marked *A*, there is at the same time a lateral vibration (while under the cut-

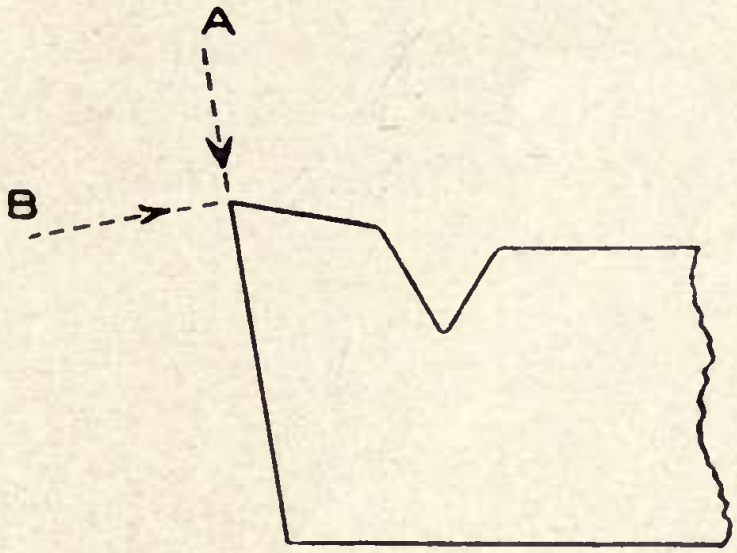


Fig. 1. A Common Form of Tool, Showing almost Level Top, a Tool with very Little Rake

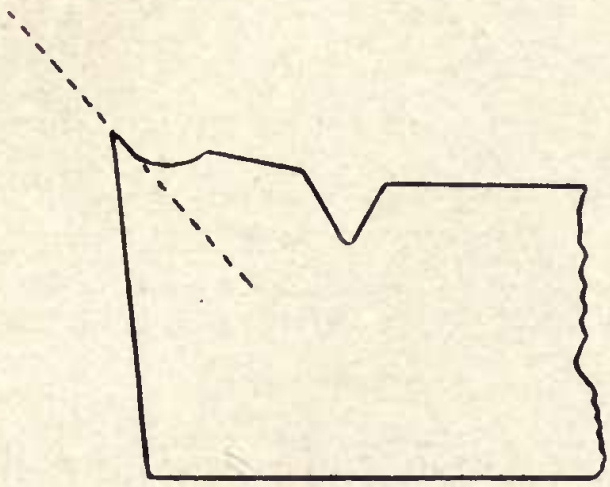


Fig. 2. An Exaggerated Case of a Tool, showing the Sharpening Action of a Chip, proving that the Tool should be Ground on the Angle Indicated by Dotted Line

ting strain) in the direction of arrow *B*. This edge-destroying vibration is what has made it necessary to give the edge a strength or backing to meet this strain.

The hollow shown in Fig. 2 was worn in the tool by the chip because some condition prevented the vibration, which usually destroys the edge first.

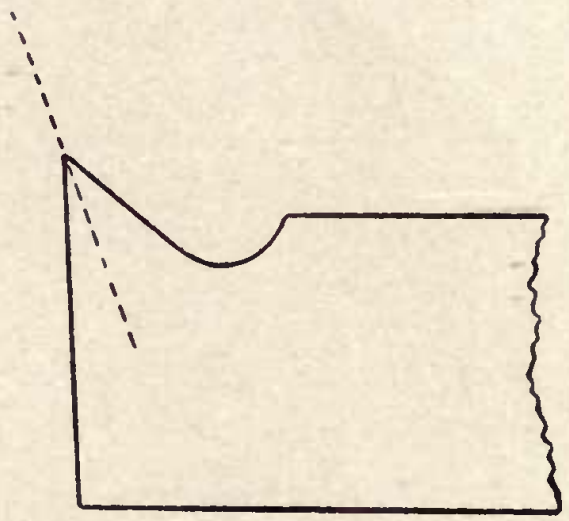


Fig. 3. Ideal Form of Cutting Edge for an Ideal Machine

The dotted line indicating the line of thrust of cutting is in line with the tool's greatest strength.

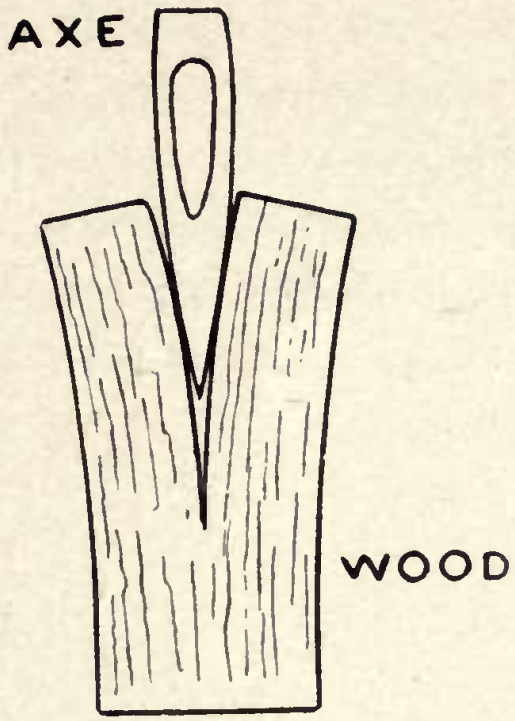


Fig. 4

Stock removing is accomplished by a splitting action and finishing surface is produced by a scraping action of the tool.

The axe shown in Fig. 4, and the cutting tool in Fig. 5, are shown with cutting edge not in contact with the metal. Although these are exaggerated diagrams they tell a true story, as shown by Fig. 2.

In Fig. 5 we have another action which leaves a fair surface. This is the regular tool used so many years in the Flat Turret

Lathe with such satisfactory results. The chip is split from the face of the shoulder and is sheared off from the surface which is left on the finished diameter. This action of shearing is better than that of the average tool in other machines, for there is no

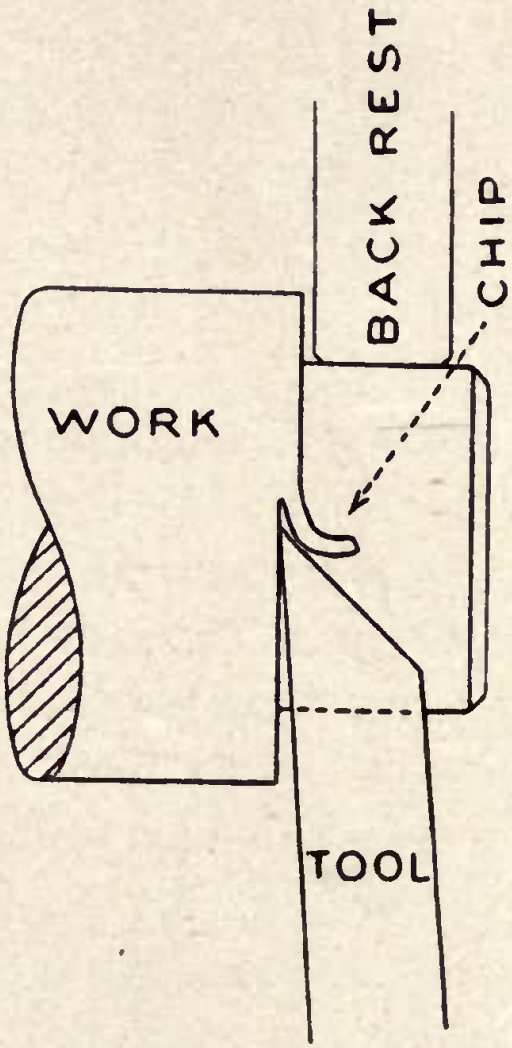


Fig. 5

pulling-out-by-the-root appearance to the finished surface. Furthermore, this tool is usually followed by the back rest, which burnishes the finished surface.

The shoulder from which the splitting cut is taken is rough until the tool is allowed to take a slight scraping cut after desired length has been turned.

The preferred form of tool for finishing is one which takes a diagonal scraping cut, as the cutter in Fig. 6 would take if it were ground like Fig. 7; that is, with rounded corner. The diagonal scraping cut is the kind taken by a spiral milling cutter. The

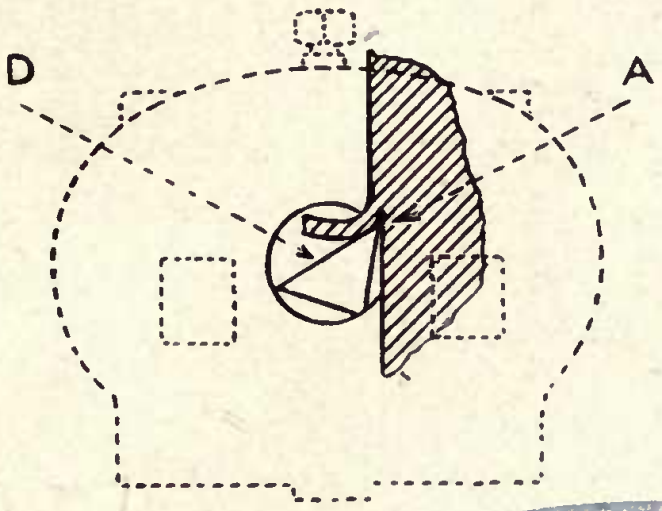


Fig. 6

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diagram, Fig. 6, shows the ideal tool removing heavy part of chip by the splitting action at *A* and finishing with a diagonal scraping cut at *D*.

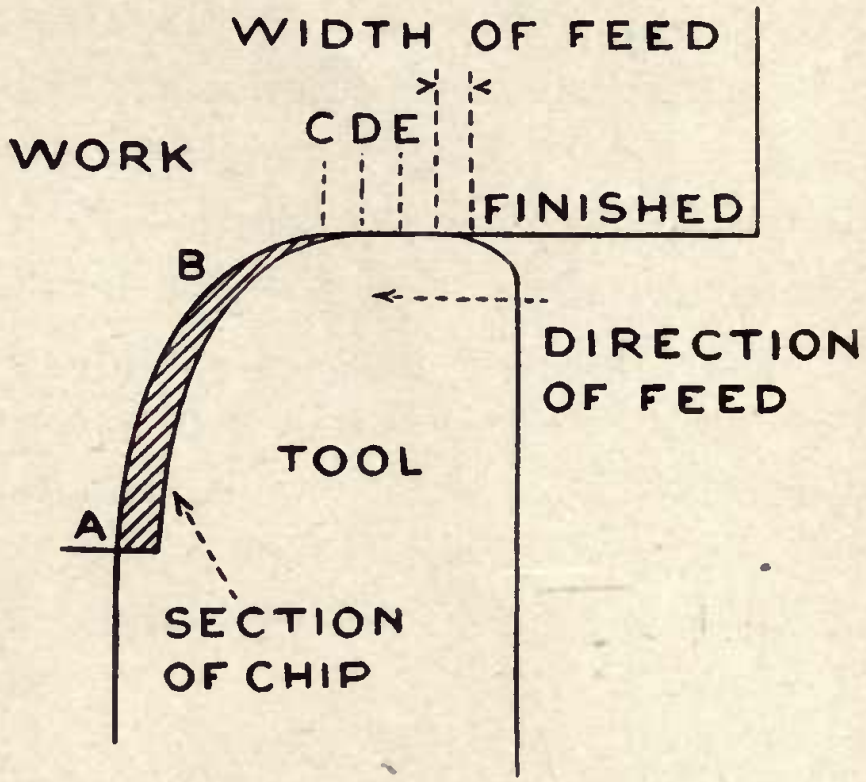
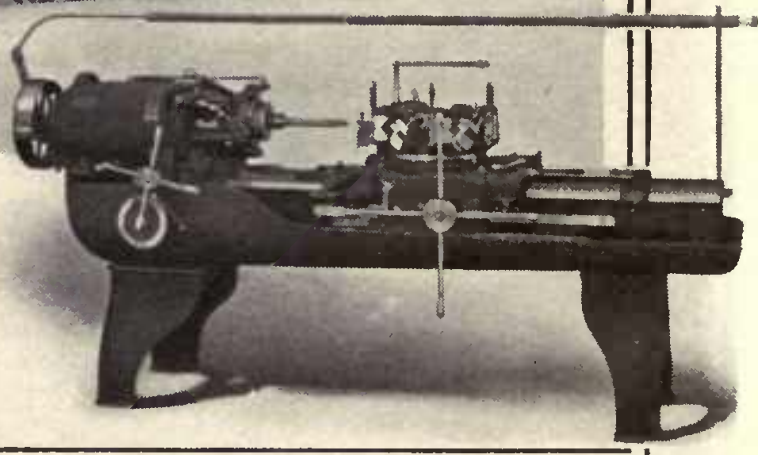


Fig. 7

Fig. 7 gives top view of tool for chucking and other operations in which no back rests or other steadying means are employed. The chip from *A* to *B* is removed by splitting action; from *B* to *C* the cut becomes lighter and the angle of the tool becomes diagonal to the motion of the work.



THE HOME
OF THE
FLAT TURRET
LATHE

THE
HARTNESS FLAT TURRET LATHE

AND EQUIPMENT, PROTECTED BY TWENTY-ONE JAMES HARTNESS PATENTS — OTHERS PENDING

GOLD MEDAL RECEIVED AT ST. LOUIS IN 1904

GOLD MEDAL RECEIVED AT PARIS IN 1900 AND SILVER MEDAL WAS ISSUED TO THE INVENTOR BOTH AWARDS WERE THE HIGHEST OBTAINABLE FOR A SINGLE EXHIBIT

COLUMBIA EXPOSITION IN 1893 ISSUED AN AWARD FOR SUPERIOR DESIGN

JAMES HARTNESS, *President*
W. D. WOOLSON, *Treasurer*
J. W BENNETT, *Secretary*

MANUFACTURED AND EXCLUSIVELY SOLD IN AMERICA BY

JONES & LAMSON MACHINE COMPANY

SPRINGFIELD, VERMONT, U. S. A.

And 97 QUEEN VICTORIA STREET, LONDON, ENGLAND

ALSO SOLD BY

M. KOYEMANN, CIVIL-INGENIEUR (*For Germany, Switzerland, Holland, Belgium, Austria-Hungary*)
CHARLOTTEN STRASSE, DUSSELDORF, GERMANY

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Jones & Lamson Machine Company
Springfield, Vermont, U. S. A.

THE HOME OF THE FLAT TURRET LATHE

THE frontispiece of this section gives a Summer and a Winter view of Springfield, Vermont, the home of the Flat Turret Lathe.

In the foreground may be seen the buildings of the Jones & Lamson Machine Company, in which all of the Flat Turret Lathes now running in this country were built.

In the lower corner, with a snow bank for a background, is shown the present form of Flat Turret Lathe, to which the following pages are devoted.

The Flat Turret Lathe was the first machine for rapidly doing general lathe work

and the first machine for accurately turning long, slender work without use of centers. Before its introduction there was no means for rapidly and accurately turning bar work having a length over ten or more times its diameter.

The working length of the original Flat Turret Lathe was 24 inches, and although this was a desirable feature, the strongest point in making friends was its simplicity and convenience of design, which made it possible to quickly adjust it for any kind of work within its limits, its product being true beyond the average product of the engine lathe and in quantity from three to ten times as great.

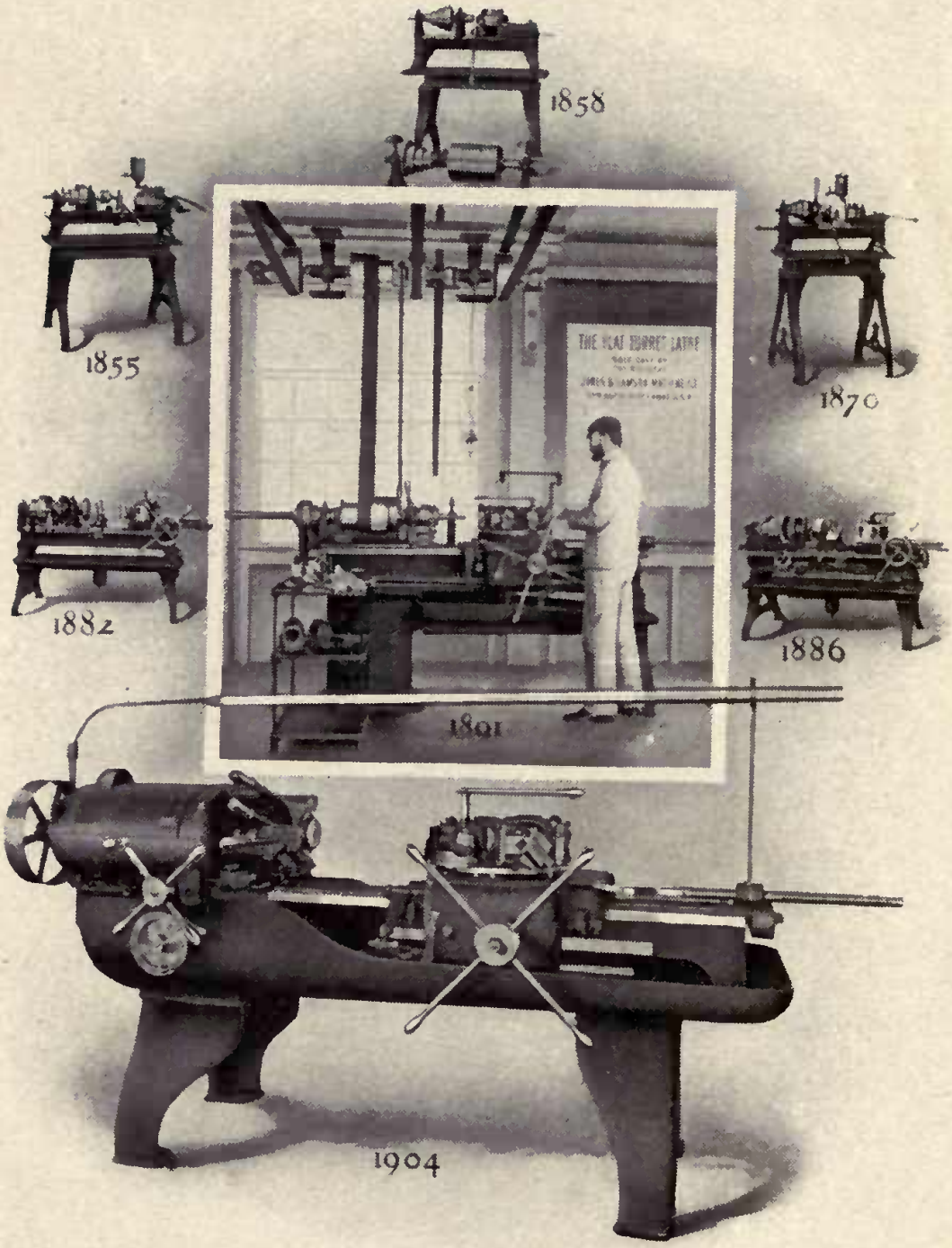
Since 1891 we have developed with care each feature of this machine and now illustrate its present form, which has already met with even greater favor than anticipated.

FIFTY YEARS' PROGRESS

THE evolution of the Turret Lathe has been the result of work of many men and many companies, but this Company has made some of the important improvements. The principal steps of our fifty years' work are illustrated on the following page and may be summarized as follows:

1855—We made the first turret machine known to us, having mechanism for automatically turning the turret.

1858—We produced the present form of high turret with the turret-turning mechanism the same as the one now in universal use.


1858
1855
1870
1882
1886
1891
1904

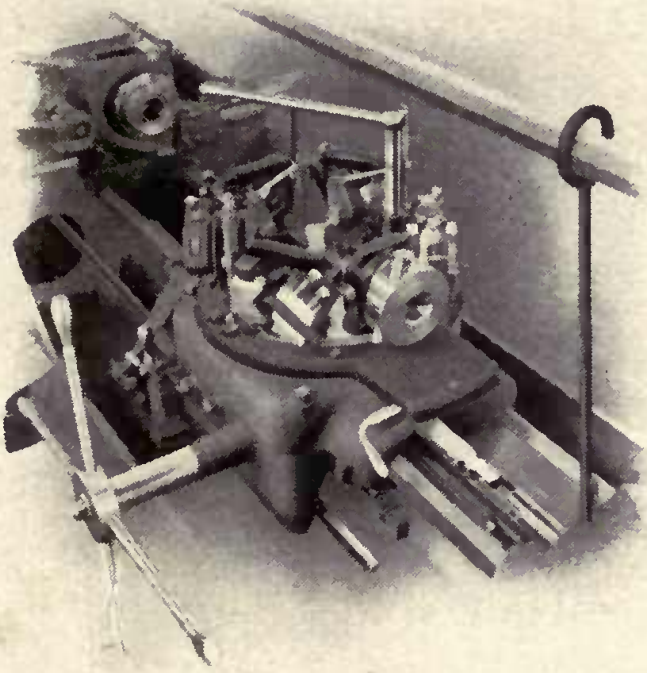
1870—One of the links in the chain of evolution, showing an automatic chuck.

1882—The first clutch back-geared machine.

1886—The same in more symmetrical form.

1891—The first Flat Turret Lathe.

1904—The first Flat Turret Lathe with cross sliding head.



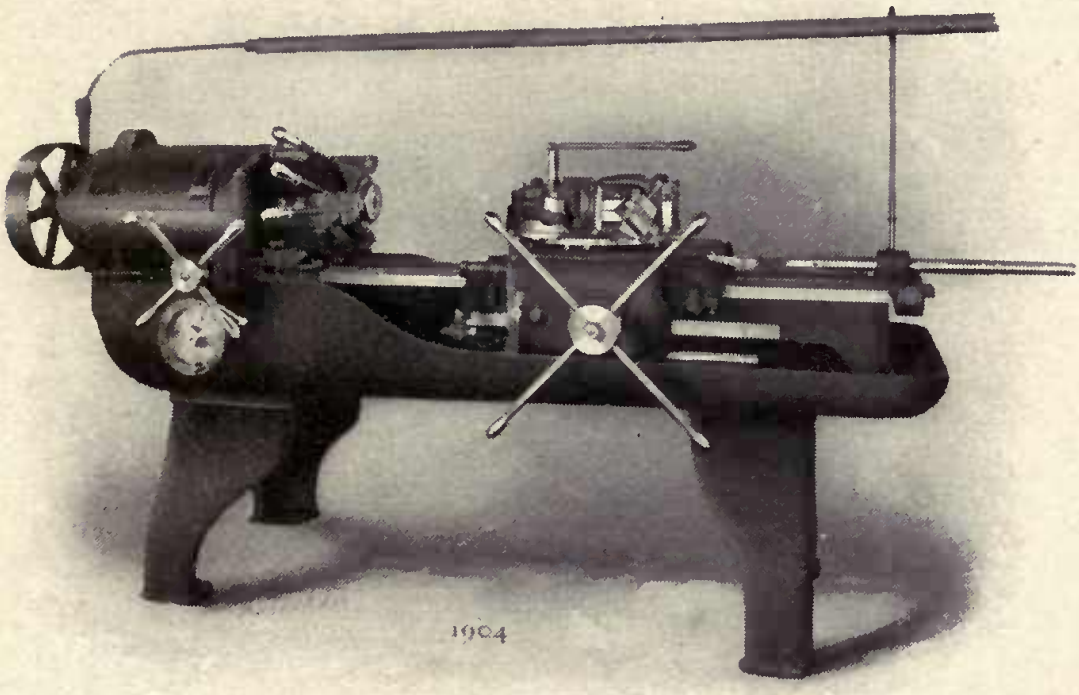
INTRODUCTORY

EVER since the introduction of the Flat Turret Lathe in 1891, it has had a steadily increasing sale and a corresponding development. The noticeable change in appearance, as now shown, is chiefly due to the new form of bed and the new cross sliding head. It is the same old machine taking on an outward shape that conforms to the growth and development of the internal mechanism.

For many years our entire plant has been exclusively devoted to the manufacture of the Flat Turret Lathe and its equipment of tools, and we have enjoyed the reputation of being the only machine tool builders making only one machine, and that in only one size. During these years we have developed several modified forms of this type of machine. Many of these have long been running on our own work. The present machine embodies the desirable features which have been thoroughly tested and

developed in these various machines, combined with the standard features of the now celebrated Flat Turret Lathe.

We now offer the machine in two sizes for both bar and chucking work.



OUR METHOD OF SELLING

WE sell only to the user, and have no other agents or offices than those given on page 67 for the various countries named. In the United States and Great Britain we have our own traveling representatives whose time is wholly devoted to the Flat Turret Lathe.

A personal inspection of your work by a specialist thoroughly versed in this branch of lathe work may be had within one or two days by wiring us, provided your plant is located in the British Isles or in the manufacturing States bordering on or east of the Mississippi and north of North Carolina and Tennessee.

Since we have our own representatives in this field, you are placed under no obligations to us by making a request for such an inspection and report or proposition.

There can be no uncertainty about price, for we quote a fixed price only, and any one may know our prices.

We make free delivery to nearly all points, and send without charge an operator to instruct your workman in the use of the machine, thus relieving you of all responsibility, except that you agree to accept and pay for the machine and equipment if we fulfill our guarantee.

The Flat Turret Lathe is made by no other maker in America. There are over 3000 now running; therefore, there is no uncertainty about this being *the* machine. It is either called the Hartness Flat Turret or the Jones & Lamson Flat Turret, but it is always the "Flat Turret." The present machine is protected by many American, British and German patents.

JONES & LAMSON MACHINE COMPANY

SPRINGFIELD, VERMONT, U. S. A.

97 QUEEN VICTORIA ST., LONDON, ENGLAND

DESCRIPTION

THE Flat Turret Lathe, like all other lathes, consists of the three important parts: (1) The head stock, having the work-holding spindle, the pulley for receiving the power for driving spindle and the necessary intermediate gears for obtaining requisite reduction and variations of speed of spindle; (2) the tool-holding carriage; and (3) a frame or bed with guideways for carriage.

It differs from all other lathes and turret lathes in the construction of these parts as follows:

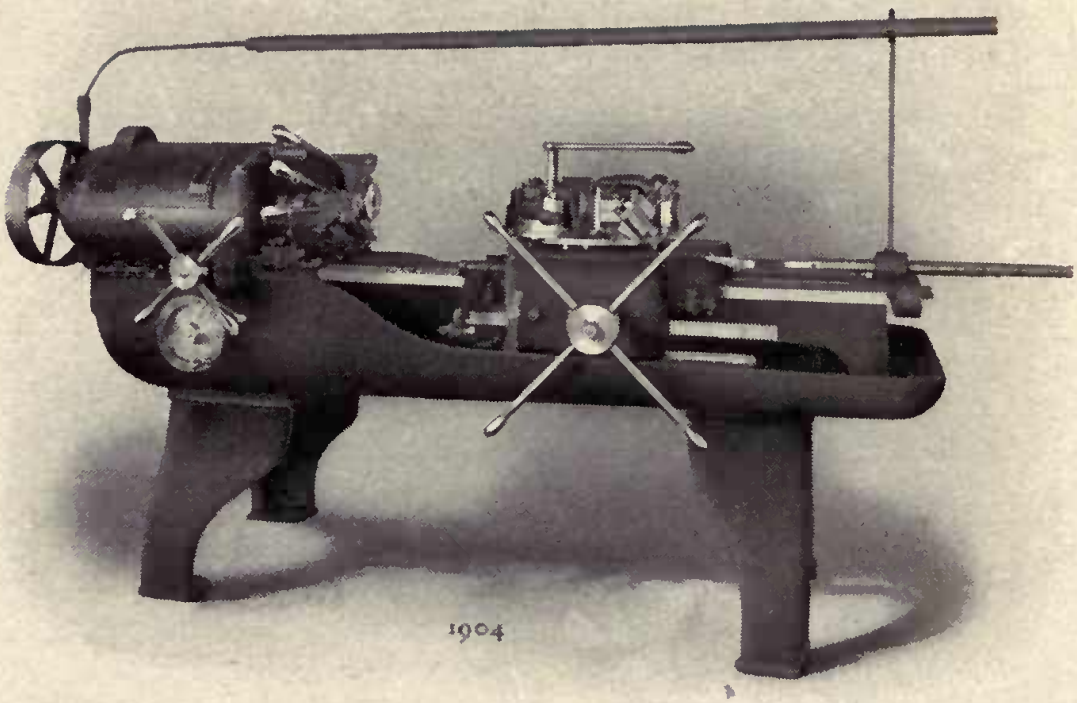
FIRST—The head stock is mounted on guideways running across the machine instead of being affixed to the bed. It contains the necessary gears and clutches for producing all the changes of speed.

SECOND—The carriage carries a flat circular plate-shaped tool holder, from which the lathe takes its name of Flat Turret.

THIRD—The frame or bed is one single casting formed with guideways which run lengthwise for the carriage and crosswise for the head stock. The lower part of the bed casting serves as a receptacle for chips and oil.

The reasons for departing from the well-established form of lathe have been set forth in the chapter on Evolution. The advantages will be readily understood after glancing at the following pages, which show the working range and details of construction, the whole combination resulting in a machine that is always in absolute readiness any hour of any day to make any piece of work of any shape quickly and accurately and to turn out work in lots of from two or three to a thousand pieces of a kind with turret lathe speed and accuracy of a well-handled engine lathe.

Turret lathe efficiency and engine lathe accuracy are our best terms, but to one who has carefully considered this subject these terms are unsatisfactory.



Front View of the 2 x 24-inch Hartness Flat Turret Lathe with Cross Sliding Head, Equipped for Bar Work

THE Hartness Flat Turret Lathe with cross sliding head is made in two sizes, and may be furnished with an equipment of tools for either bar work or chuck work, or a double equipment for both bar and chuck work.

The smaller machine (above shown) is called the 2 x 24, and when equipped with the automatic die outfit of tools it turns out the same work as the original 2 x 24, ex-

cepting that the hole through the spindle is now made 2 3/8 inches instead of 2 1/8 inches. For various details of working range and outfit for bar work, see pages 84 to 93.

Itemized outfit, pages 190 to 193.

This machine, equipped for chuck work, is described on pages 88 to 93. See also pages 132 to 189.

The machine may be ordered with either the chucking or bar outfit, and supplied later with the other outfit, if for any reason the machine should be changed from bar to chuck work, or *vice versa*. Since the chucking outfit is comparatively inexpensive, it is frequently ordered with the bar outfit of one or more machines of a lot, so that at least one machine may be used on short notice for chuck work.

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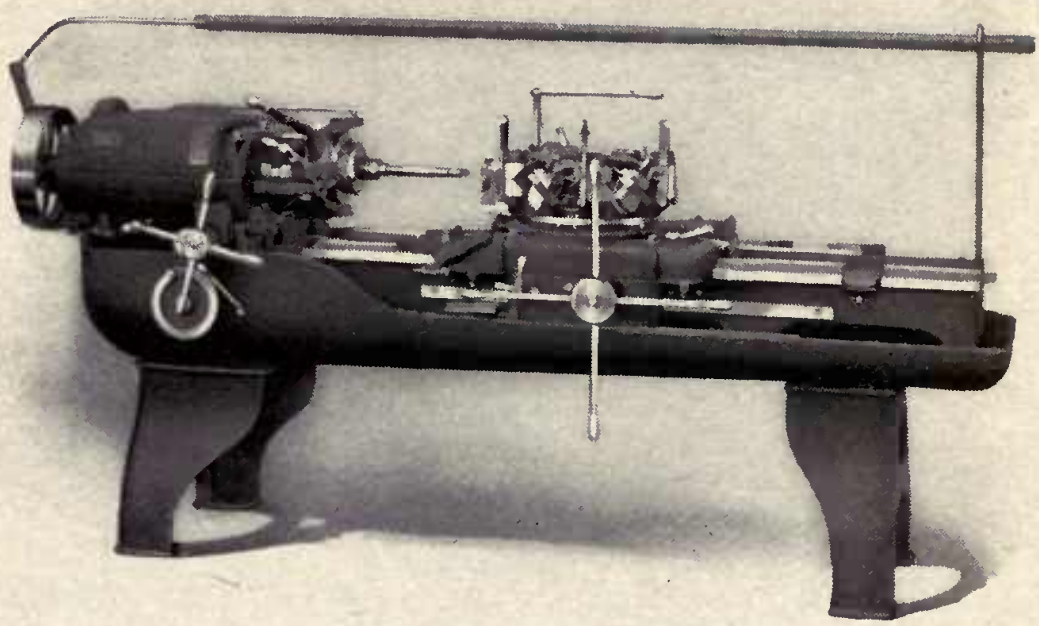
MAIN DEPOT
WORKS, ALAMEDA

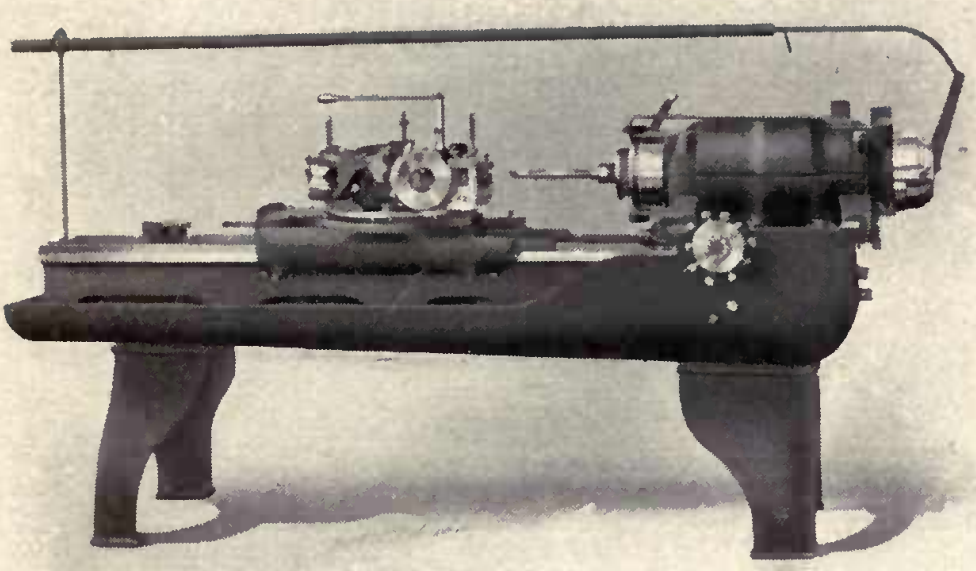


Front of 3 x 36-inch Flat Turret Lathe with Cross Sliding Head, Equipped for Bar Work

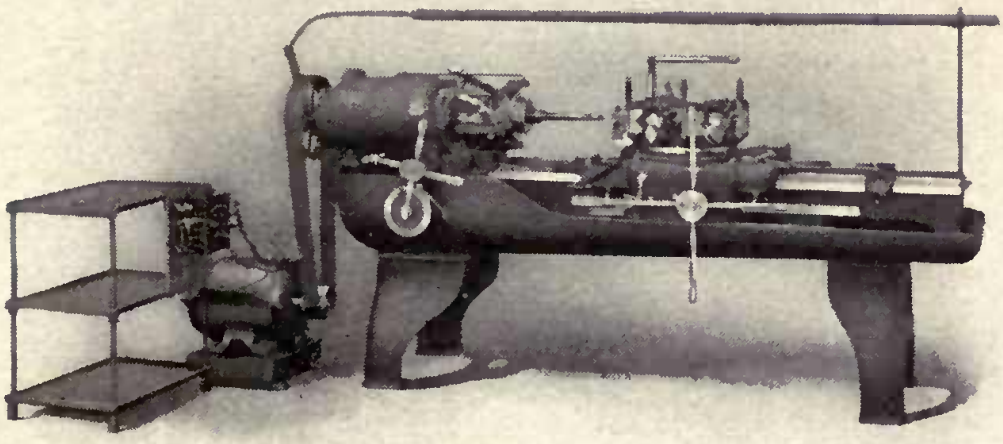
THE machine shown above, and on opposite page, is the 3 x 36-inch size. It is shown in these three views arranged to handle full bars of stock up to 3 inches in diameter, turning pieces up to 36 inches in length of the class of work shown on the following pages. It may also be equipped for chuck work up to 14 inches in diameter, and is illustrated and described as a chucking machine on pages 132 to 189.

Itemized outfits on pages 194 to 197.

This machine may be ordered with either the chucking or bar-working outfit of tools,



Back of 3 x 36-inch Flat Turret Lathe with Cross Sliding Head, Equipped for Bar Work

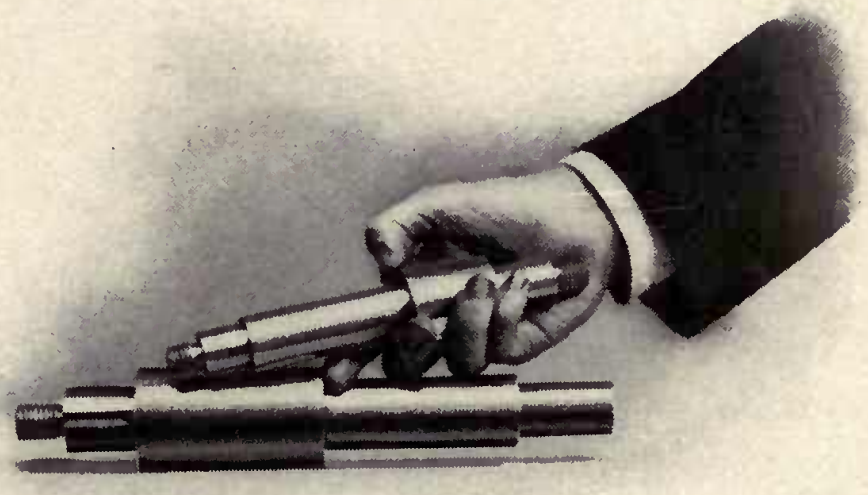


3 x 36-inch Lathe with Motor Drive. It may be driven from countershaft overhead if desired

and supplied later with the other outfit. Since the chucking outfit is comparatively inexpensive it should be ordered with the bar.

WORKING RANGE

THE work shown on this page and on page 86 is the product of the Flat Turret Lathe with the automatic die outfit (outfit D).



In the 2 x 24 machine this outfit turns all diameters up to 2¼ inches, and all lengths up to 24 inches, and cuts all U. S. standard screws from ⅜ to 1¼ inches, inclusive, by sixteenths. (Whitworth, Metric or V standard furnished if desired.)

Items of outfits on pages 190 to 193.

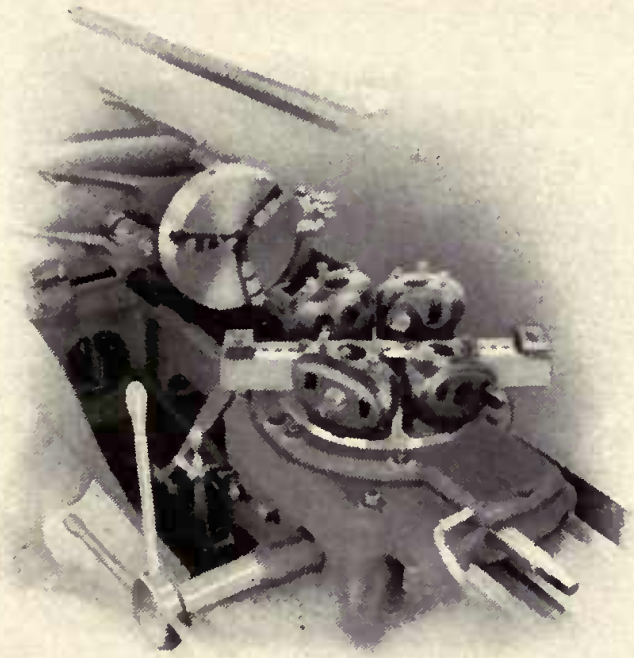
The same kind of work is turned out by the 3 x 36 with automatic die outfit, which turns diameters from 3 inches down, and lengths up to 36 inches, and cuts screw threads from 1 to 2 inches, inclusive, U. S. standard. (Whitworth, Metric or V standard furnished if desired.)

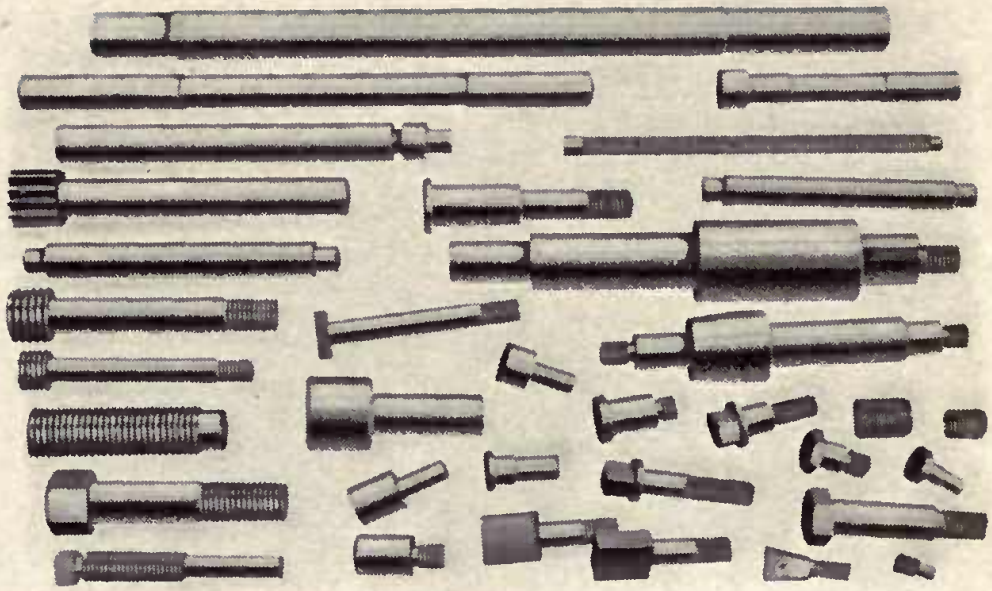
Items of outfits on pages 198 to 201.

SPECIAL EQUIPMENT

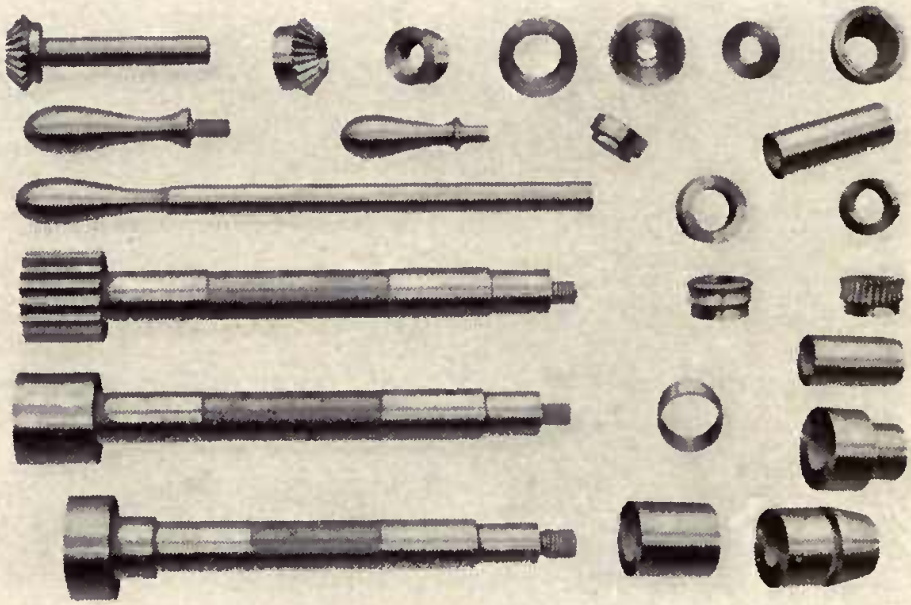
In addition to the outfit D, the 2-inch die may be furnished for the 2 x 24, and the 3-inch die for the 3 x 36 machine.

The 2 x 24 machine is also made for turning 42 inches in length.





Bar Work. Samples of pieces made from the bar



Bar Work. Samples of pieces made from the bar

MULTI-STOP AND DOUBLE TURNERS

FIG. 1 illustrates the advantage of the *double stop* for each position of the turret, and the *double* adjustment of each turner. This piece has six finished diameters and six shoulders, and is turned by only three turners, which occupy only three positions on the turret. This not only leaves the remaining positions free

Fig. 1

for other tools, but it saves the operator the time and energy required to run the turret slide back each time.

All this is obtained without complication, and without introducing any features that are annoying when not in use.

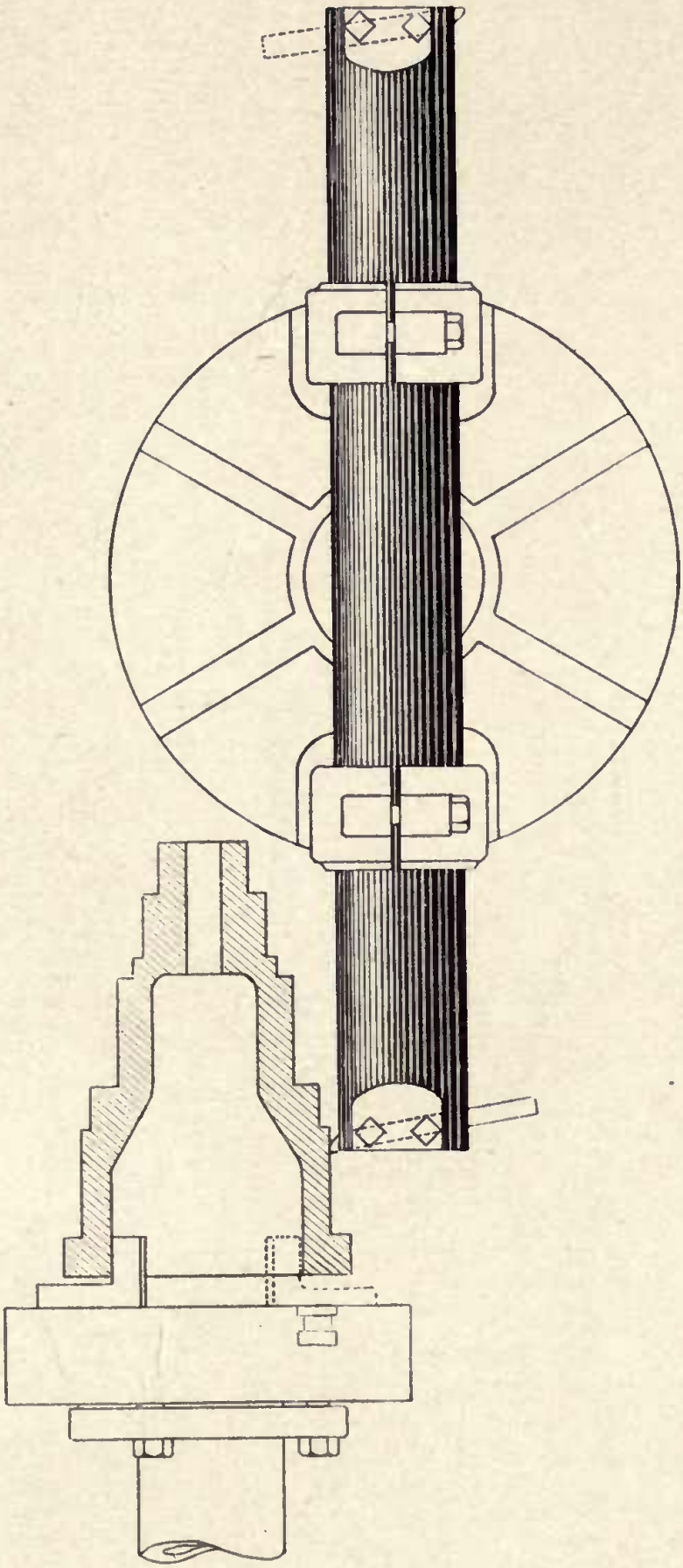
In addition to the double stop for each of the six positions of the turret, we have an extra stop, consisting of a pin which may

be dropped into any one of the six holes at the rear of turret slide. This makes it possible to borrow five extra stops for any one of the tools, and gives to this tool seven length or shoulder stops, and leaves one stop for each of the remaining tools.

The illustrations, Figs. 2 and 3, give examples of what one tool can do in this machine on chuck work, when we take advantage of the seven length stops and the seven shoulder stops of the cross-feed head.

Of course, in general practice three or four stops for one tool is all that will be needed, but since the modern cutting steels have greater durability, there is nothing lost by giving each tool all the work it can do.

Outer face and all shoulders and diameters may be accurately finished to independent stops by one tool. When roughing and finishing cuts are required, the roughing tool can be set near enough to use the same stops that are accurately set for the finishing tool. When an extra tool is used to give a



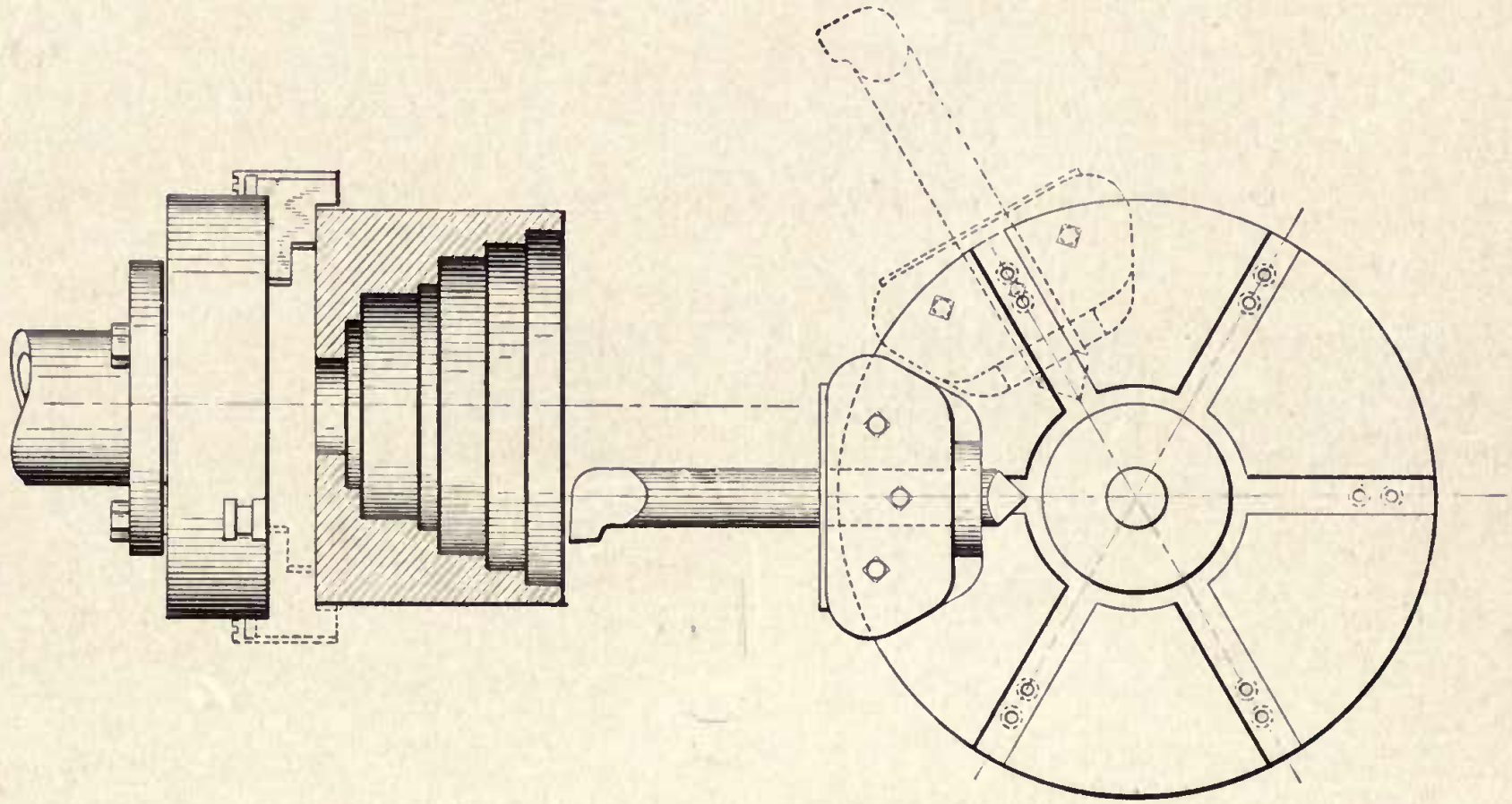
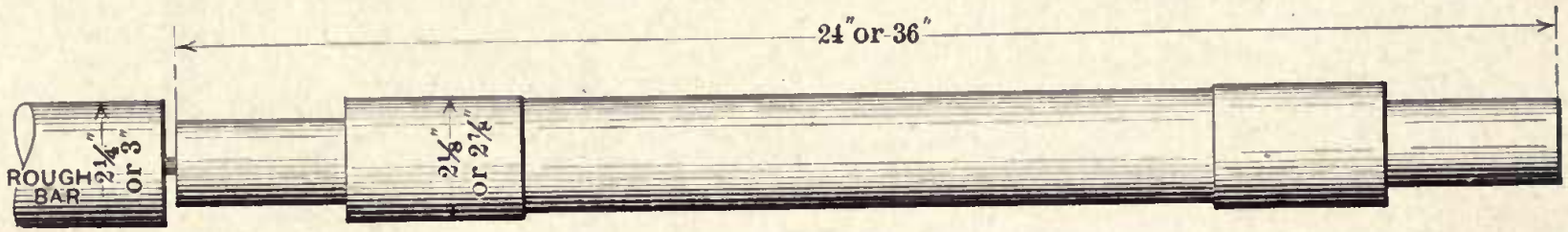


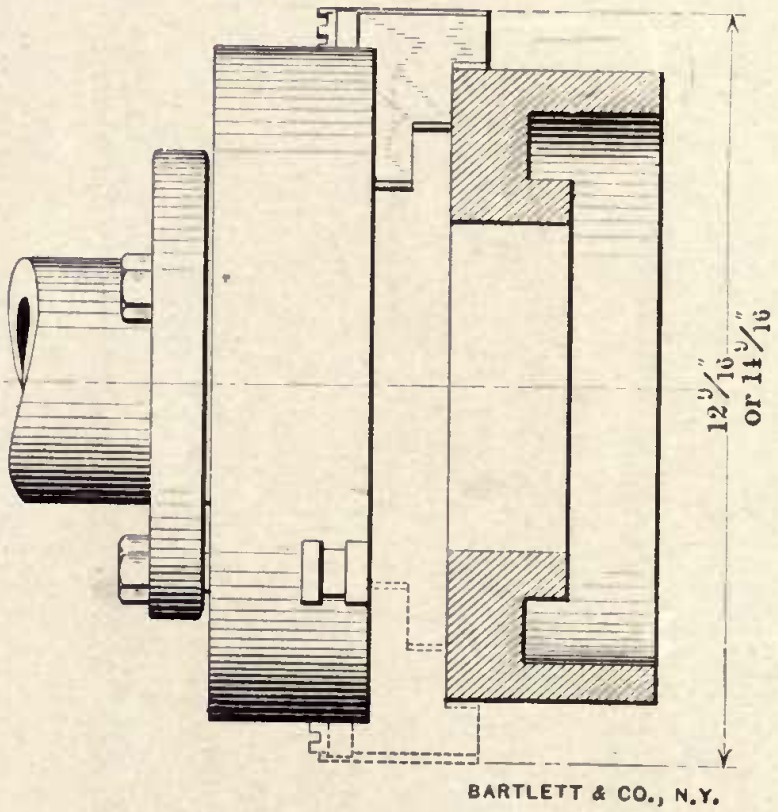
Fig. 3. Showing use of Seven of the Twelve Turret Stops by One Tool—also Seven of the Ten Cross-slide Stops

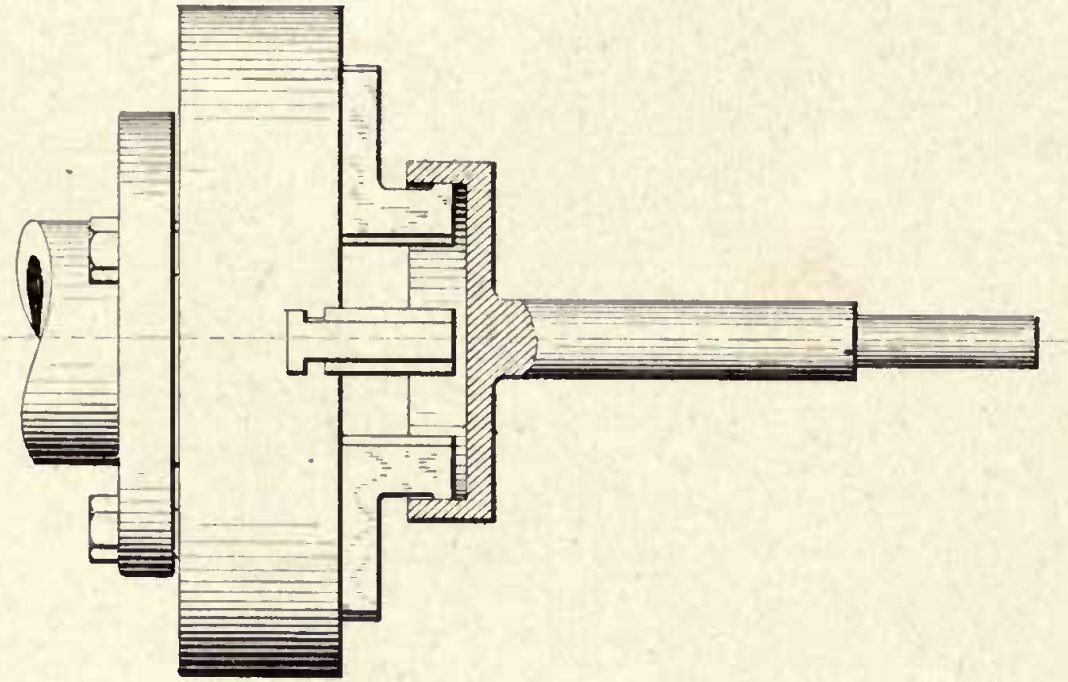


Illustrating Largest Working Dimensions for Both Machines

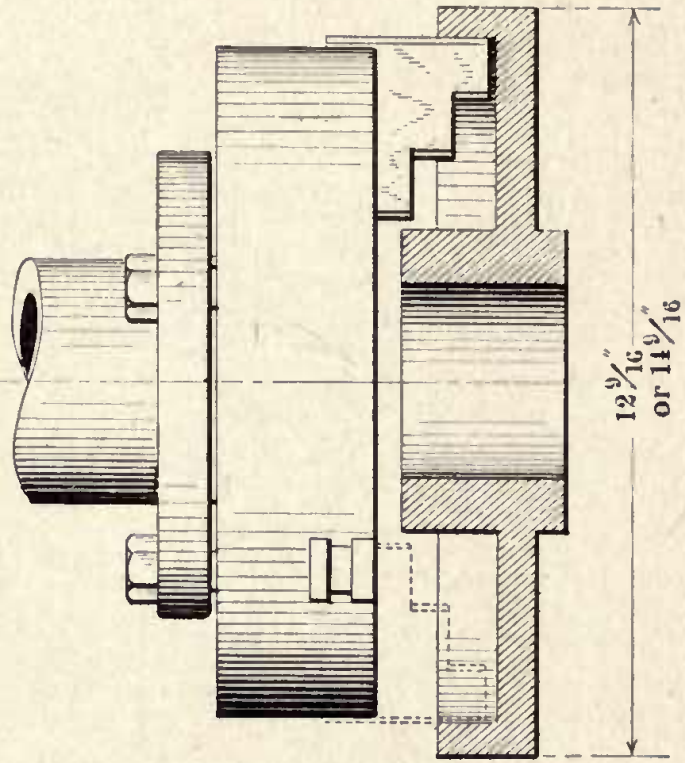
roughing cut it is set as indicated by dotted lines in Figs. 2 and 3.

We find it difficult to illustrate all of the classes of work that can be turned out by this machine, but a little thought will suggest many forms that may be readily handled in bar and chucking work, both steel and cast-iron, on account of the many provisions for bringing both turret and cross slide up to fixed stops, either by power feed or by hand.

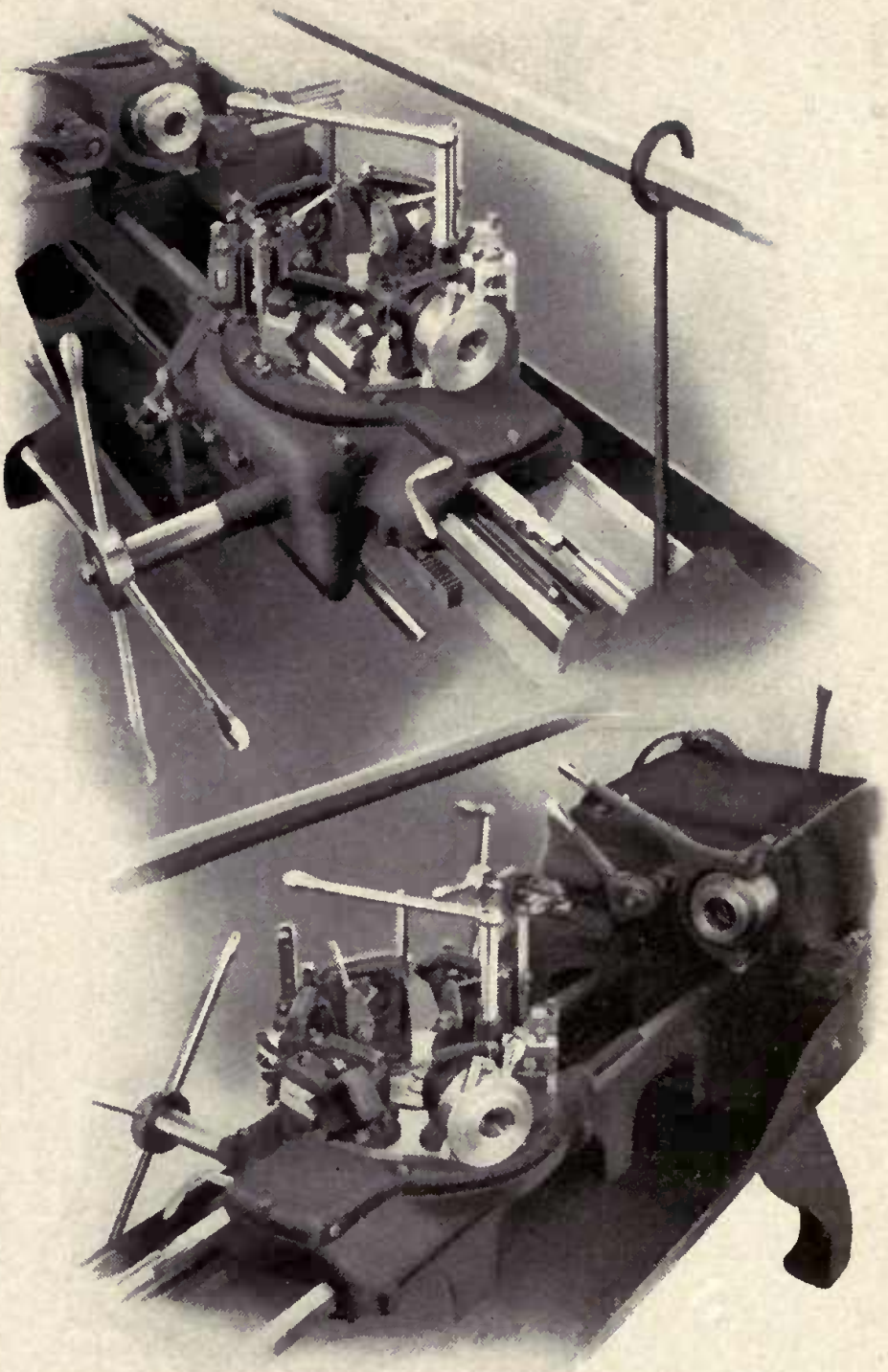




Sample of Work Requiring Bar and Chucking Outfit



Illustrating Largest Working Diameter of Both Machines



Front and Back Views of Turret with Tools for Bar Outfit

TURRET DESCRIPTION

THE turret is a flat circular plate ; it is mounted on a low carriage containing controlling mechanism. The connections of the turret to the carriage, and the carriage to the lathe bed, are the most direct and rigid, affording absolute control of the cutting tools. The turret is accurately surfaced to its seat on the carriage by scraping, and securely held down on that seat by an annular gib. In the same manner the carriage is fitted to the V's of the bed ; the gibs pass under the outside edge of the bed.

The index pin is located directly under the working tool, and so close to it that there can be no lost motion between the tool and the locking pin. The turret is turned automatically to each position the instant the tool clears the work on its backward travel, and it is so arranged that by raising and lowering trip screws near the center of the turret, it may be turned to three, four or five of the six places without making any other stops.

A simple, accurate stop mechanism for the turret slide provides twelve independently adjustable stops, two for each of the six positions of the turret, or any other division required by the operator. These stops connect with the twelve flat stop bars clamped side by side in the groove in top of the bed. For more detailed description see page 222 on operating instructions.

The *feeding mechanism* for the turret slide and the cross-feeding head receives its power through a speed-varying device which is under the convenient control of the hand wheel at head end of bed. One revolution of this wheel gives the full range of feeds, from drilling feed of 120 per inch to coarse turning feed of 10 per inch, and every intermediate speed.

A spring torc weighing device on the feed rod gives the pulling power of this feed mechanism a known value. This device yields at a certain predetermined pressure.

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In operation the carriage is fed forward until it reaches one of the stops, against which it is held by this pressure till disengaged by the operator. Arresting the feed without releasing the carriage gives the tool a chance to accurately face the shoulder, leaving a smooth surface instead of the ragged face left when carriage is released under full cut.

It has been the practice heretofore to arrange the positive stop a thirty-second of an inch beyond the knock-off for the feed, and in the usual operation of a machine of this kind the feed knocks off, and then the turret slide, released, jumps back, and the tool digs in, cutting a slight groove just back of the shoulder. When on work requiring exact shoulder distances or smoothly-finished shoulders, the operator brings the slide against the positive stop, holding it there with as nearly as possible uniform pressure until the turner has surely faced its full length. In the present machine the turret is always fed against the positive stop

and held there with a uniform pressure, insuring the most accurate results for shoulder length.

The feed reversing for turret slide is effected by use of a worm with right and left-hand threads, either of which may be engaged at will.

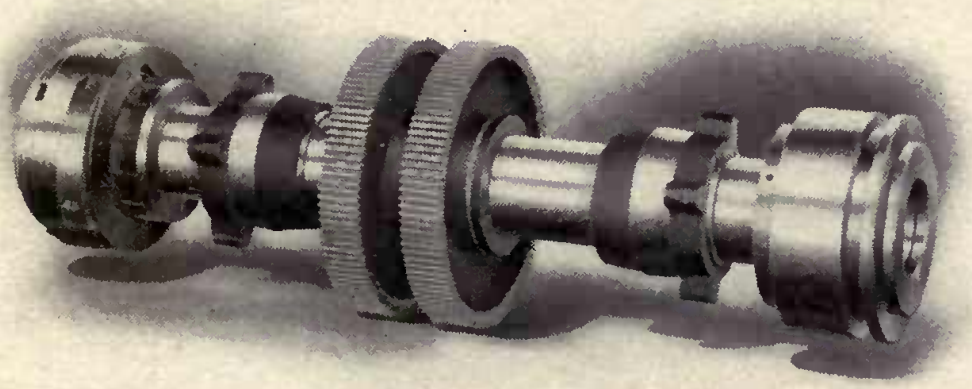
CROSS-SLIDING HEAD

THE distinctive feature of the original Flat Turret Lathe was the flat, plate-shaped tool holder from which the lathe took its name. The original work-holding head stock possessed many distinctive features, such as the automatic chuck and roller feed, but it contained the now nearly obsolete cone pulley drive and back gear scheme. In the present machine we have combined an ideal scheme of speed regulation with many other desirable features.

The cross-feeding feature of the head grew out of our desire to get the best form of self-contained speed variator. After trying several combinations and positions, we

found it best to arrange all the shafting and gearing in a horizontal plane, so that the lower half of these running parts could be *submerged in oil* to insure perfect lubrication.

This determined the adoption of a shallow, pan-shaped frame for the head stock, into which were placed all the clutches and



Main Spindle with Automatic Chuck and Roller Feed for Bar Work, and Showing Main Bearing

bearings, including main spindle bearings. The natural form of bed for holding this head stock made the way open to give the head stock a cross travel, which we had long realized was a most desirable feature.

A most fortunate combination was the result. We not only obtained a most com-

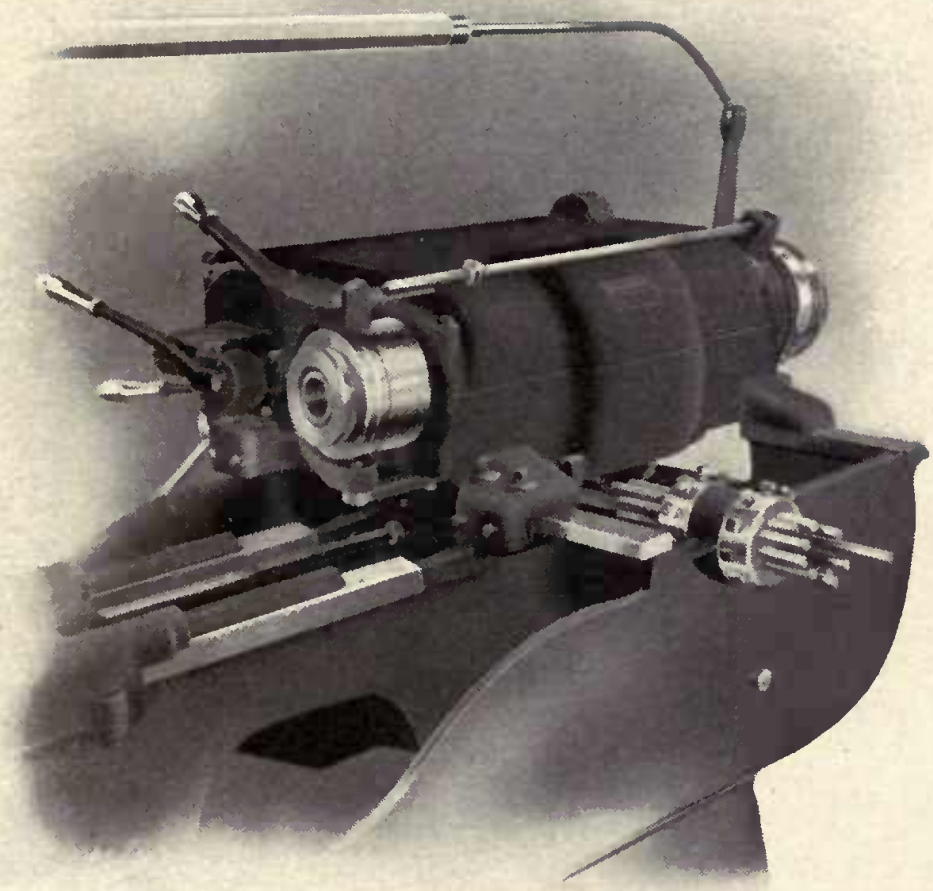
pact and symmetrical machine, but in one machine we succeeded in getting practically all of the features made desirable by present-day conditions.

The sliding head stock is securely gibbed to guideways running across the machine, thus giving the work-carrying spindle a cross feed relative to the turret, or, in other words, providing a cross feed for each tool.

The value of this feature is not only for chuck work, but for many other kinds of work.

The single drive receives power at a constant speed and in one direction, and all of the changes for variation and direction of speed are obtained by clutches and gears between the power-receiving shaft and the spindle.

Since the pulley receiving the power is driven at a constant speed, it may be belted to *countershaft* above or to a constant-speed electric *motor* on the floor at the head of the machine. The motor requires only our compensating base to maintain even tension of the belt. No controller is nec-

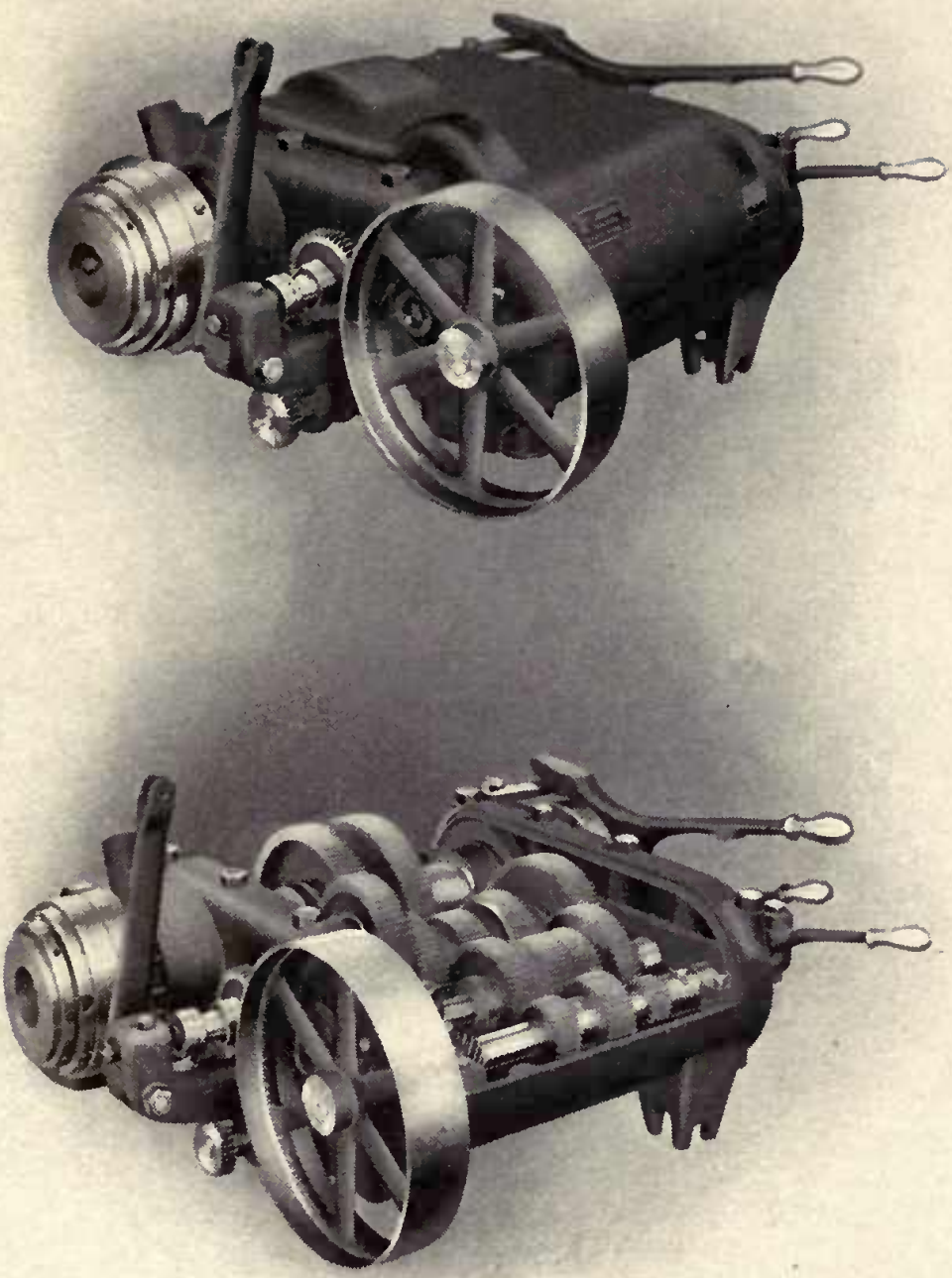


Cross-feeding Head, showing the Rotary Stop Holder Containing Ten Stops

essary, only a starting box, and since we do not vary the motor speed, it is not necessary to provide a motor four times the nominal size to compensate for loss of power due to reduced speed. Since we use belt connection, any kind of motor may be used, thus avoiding the delay incident to getting a given type of motor.

The *new high-speed* steels tax the running bearings of a machine to their limit, and to meet this we have used bronze bearings for the driving shafts; and all of these bearings get a continual shower of oil when running, for they are enclosed in the chamber formed by the shallow, pan-shaped head stock and its lid.

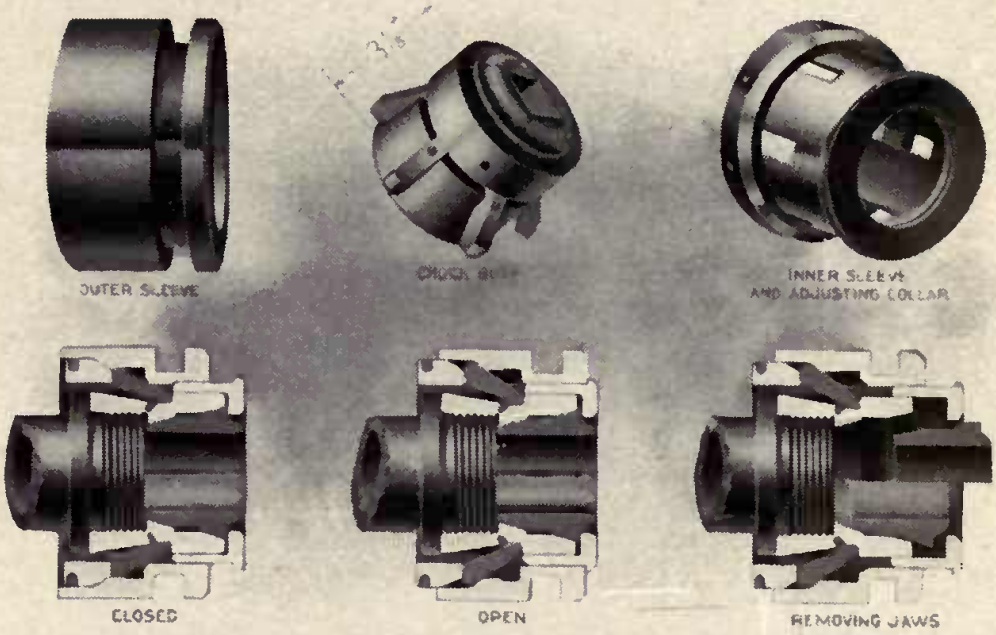
The cross-sliding head is provided with *ten stops* carried in a revolving holder, which is turned at will by the operator.



Sliding Head Stock with and without Cover. Pulley shaft is driven at constant speed and in one direction only. All changes of speed effected by two lower levers at right-hand side, the reversing by lever at left-hand side, to which shipper bar is attached. The upper lever at right actuates the automatic chuck and roller feed

AUTOMATIC CHUCK

(PATENTED)



THE automatic chuck and roller feed handle the rough bars of round, square, octagon, hexagon and flat stock, presenting a new length and gripping it while the machine is running.

The automatic chuck is one of the essential features of the machine in its equipment for turning work from full lengths of bars. Its strong and unyielding grip gives a rigid presentation of the work, which is of paramount importance.

The jaws are of unbreakable form and may be readily made for any size or shape of material within the spindle's capacity.

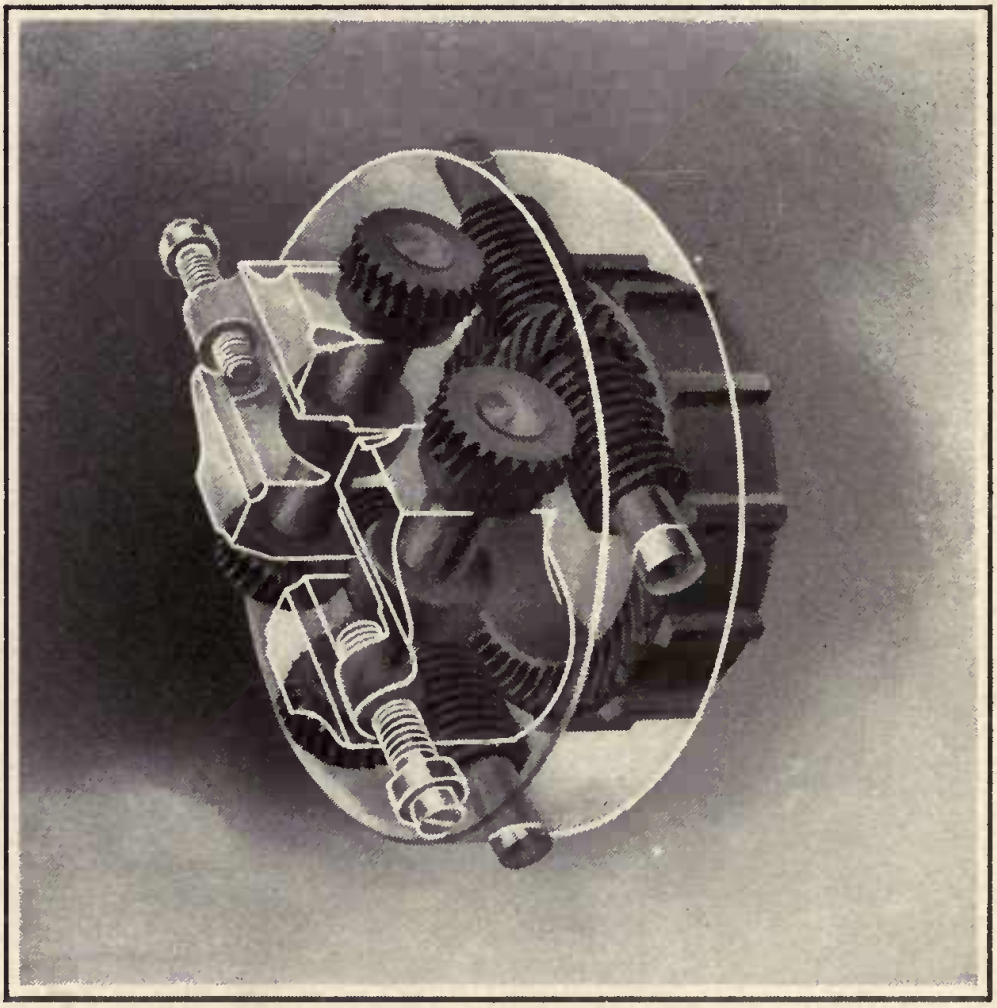
All sizes, from 2½-inch down to ½-inch in the 2 x 24 machine, and from 3-inch down to 1-inch in the 3 x 36 machine, and any of the above-mentioned shapes, may be held by the jaws furnished in automatic die outfits of tools.

Special attention is called to the superior construction of this chuck for handling rough bars of stock.

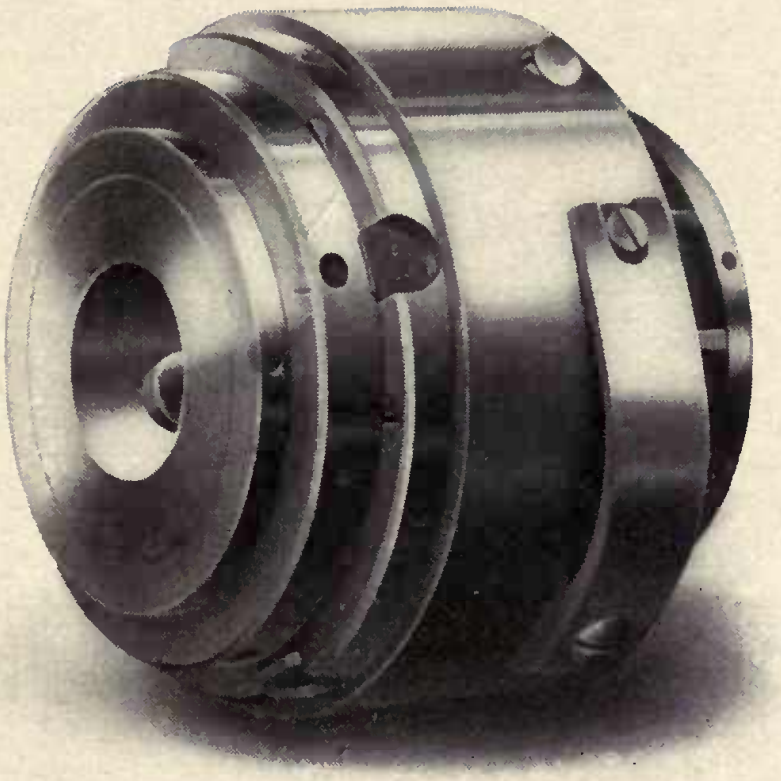
This chuck is used in connection with the roller feed, which is described on the next two pages.

ROLLER FEED

STOCK-FEEDING devices come and go, but this, the original revolving roller feed, seems destined to stay. Each year something new is tried, only to be found unsatisfactory. As the matter stands now, there seems to be no other suitable power roller feed obtainable.



Roller Feed



Roller Feed

The roller feed pushes the bar through the spindle and chuck till the end strikes the stock stop on carriage; then the rolls slip till the chuck is closed. It is started into action by the same lever and motion that opens the chuck. Its friction rolls are held in contact with the bar of stock by stiff springs. It is the only roller feed that is actuated by the power of the machine, for feeding round, square and hexagon bars.

TURNERS AND CUTTERS
OUTFIT D

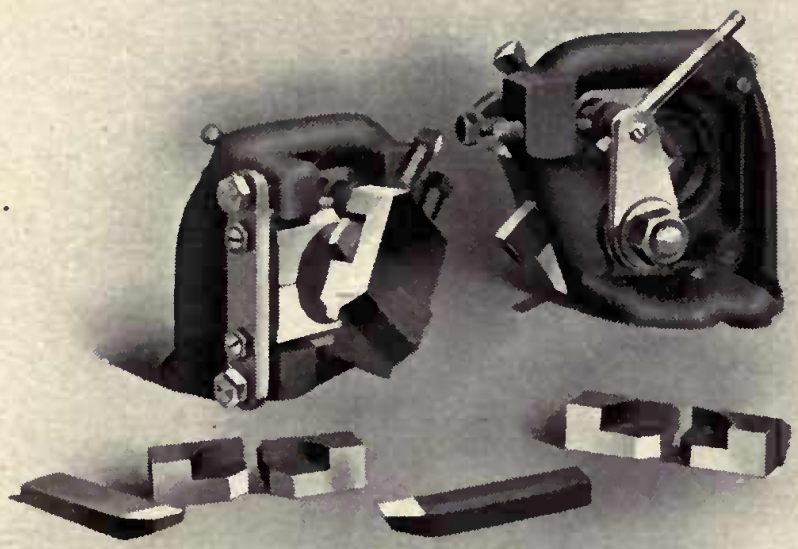
THIS turner is the result of the natural development of the original turner around which the Flat Turret Lathe was designed.

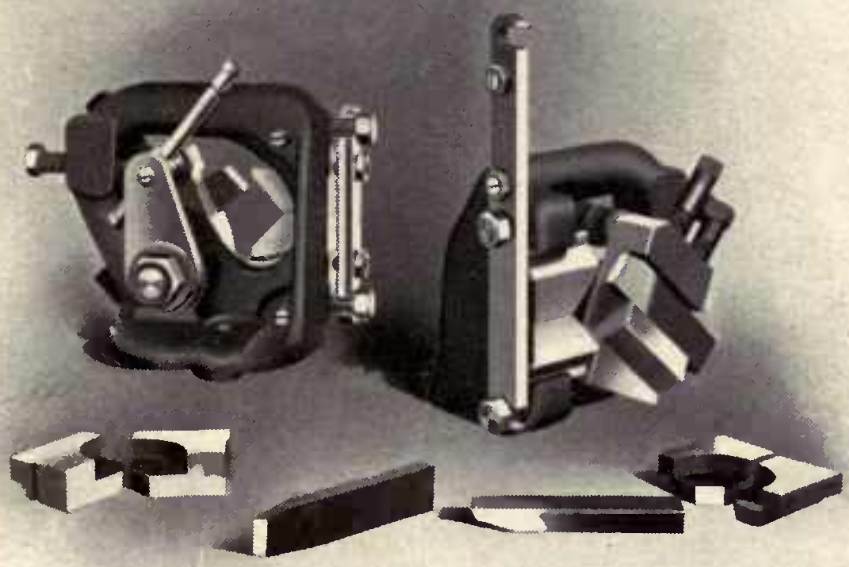
Experience has proven that this cutter and means of holding and adjusting it are the best.

The present turner is provided with a double adjustment for both the cutter and back rest, but it has lost none of its original convenience and simplicity, and may now be used for turning only one diameter without any inconvenience from extra adjustment.

We retain our quick means for withdrawing the cutter and back rest for opening the turner when passing over a larger diameter.

The cutter is of rough 1-inch by ½-inch high-speed steel, is held in the pivoted tool block of forged steel, which in turn is accurately fitted to the hollow frame.



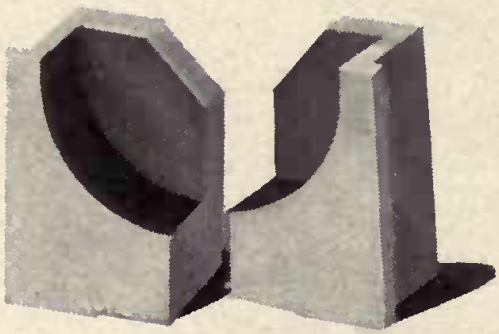


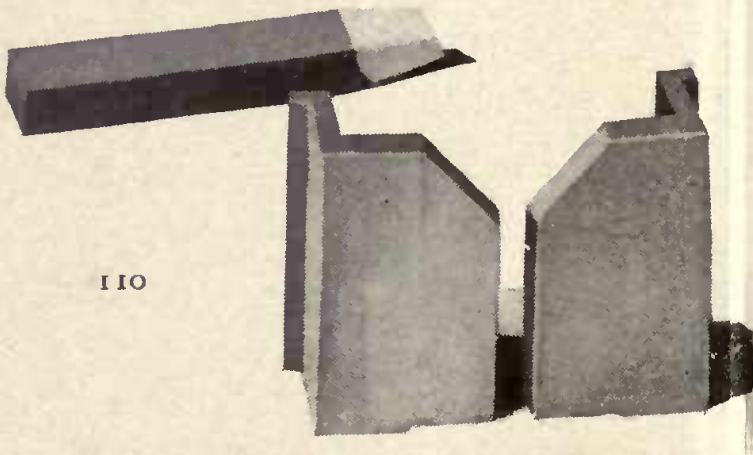
Groups of Turners and Cutters, Outfit D (Small Size)

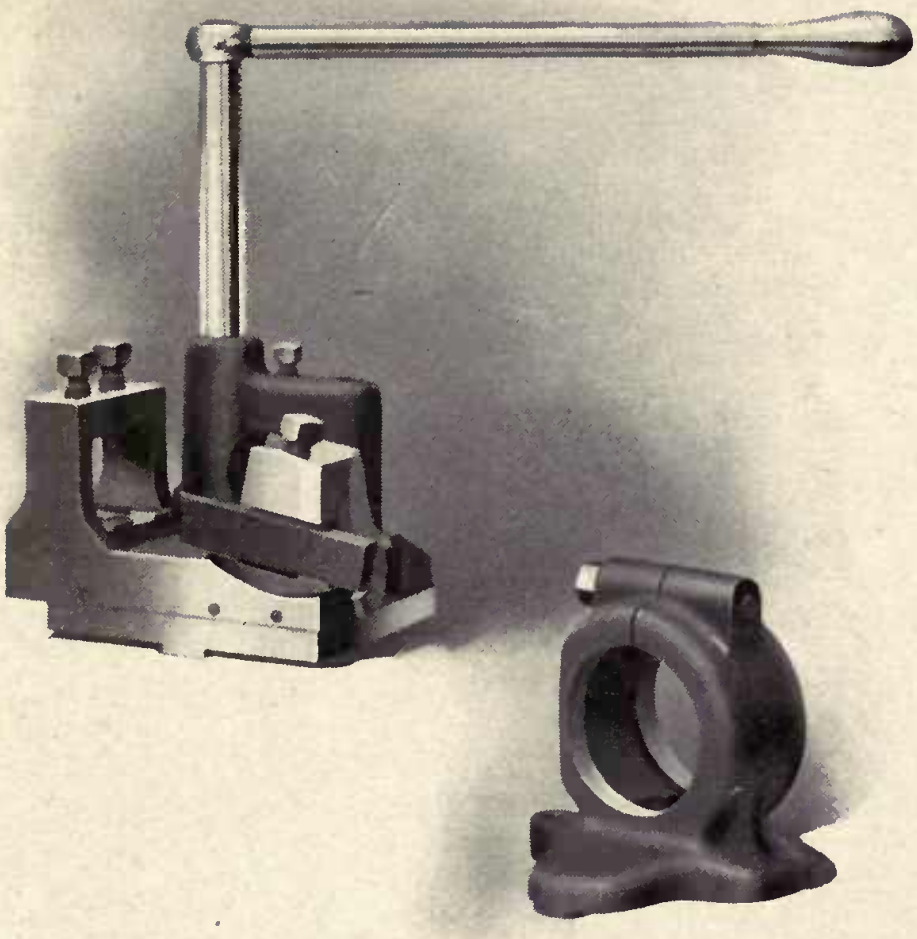
The adjustment of the cutter is effected by two screws arranged side by side. These screws take bearing against cams on cam shaft, which is controlled by a handle similar to that used in a machinist's bench vise. These cams are diametrically opposite, so that either may be brought into action by a half turn of the handle.

The back rests are controlled by a double latch in order to obtain the double adjustment.

The hollow frame serves as a conduit for the oil which enters the base of the frame through the turret. The oblong opening in the frame over the cutting tool delivers a large, slowly-moving stream of oil directly on the cutting edge.







Cross Slide and Tool Holder

The turret cross slide is made very compact. The sliding tool block is closely fitted and gibbed to the base, which is bolted securely to the turret. A long lever and a small pinion furnish means for feeding the cross-slide tools. The sliding surface is so close to the work that its slight necessary

amount of looseness is never greater at the tool point.

This slide is used as a cut-off, also for holding broad tool, especially when the latter is to be used near the outer end of a long and slender piece. For such broad tool work on a slender shaft a supporting bushing is fitted to the hole in upright.

The tool holder furnishes convenient means for holding drill chucks, reamers, taps, etc.

DOW PUMP & DIESEL ENGINE CO.
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OUR CLAIMS

The only Flat Turret Lathe.

The only turret lathe having cross-sliding head.

The only turret gibbed at the outer edge.

The only turret having locking pin directly under the working tool.

The only turret slide having double stops for each position of the turret.

The only single-drive turret lathe.

The only turret lathe in which all speeds and feeds are instantly obtainable.

The only practical drive for either electric or countershaft drive.

The only machine with universal outfit of tools for either bar or chucking work.

No cross slide between turret and work; hence the tools may be made much shorter and stiffer than where it is necessary to over-reach an intermediate cross slide or carriage.

Seven of the twelve turret stops may be used for one of the tools.

Turret stops operate in either direction.

Feeding and stop mechanism accurately measure the pressure with which the turret slide is brought against the positive stop, thus insuring accurate shoulder work.

No troublesome oil pipe and no swing joints.

All spindle driving gears, etc., partially submerged in oil.

All bearings hung to insure perfect alignment.

Cover of head conveniently removable. Adjustment of frictions outside of head.

Clutch scheme gives three speeds for each lever: fast at one side; medium at opposite extreme position; and when in middle position, with both fast and medium clutches disengaged, the slow-moving silent ratchet engages and carries it along, giving the third speed.

Turret turns automatically to the position desired, skipping other positions.

Figures that tell. Swing only 12 and 14 inches; turret diameters, 16 and 18 inches; spindle outside diameter, 4 inches.

Lathe rests on three-point bearing. An unsteady or unnatural foundation will not twist the bed.

The only turners having double size turning adjustments.

The only turners in which the tool and back rest may be quickly withdrawn without disturbing the adjustment.

The only turning tools that do not overhang.

The only machine in which the stock stop operates at the back end of travel.

The only turret lathe taking a cut on long work from, instead of toward, the chuck ; and this is the only method of turning long work true.

Oil flows in large, slowly moving stream through the turret and hollow frame of the turner that is in working position ; not in a little stream, sputtering at high pressure.

Automatic chuck grips any shape of square, round or hexagon up to the spindle capacity.

Double adjustment of turners, combined with double turret stops, greatly reduces total travel of turret slide.

The only turret in which index locking pin for the turret is nearly as far from center of turret as the point of the turning tool. In other machines the slight necessary looseness at turret center and locking pin allows from two to more times the movement at the tool point, which is more than twice the distance from turret center.

No mechanic would expect to get very accurate control by an index wheel one-fourth to one-fifth the diameter of the work. Other turrets are of comparatively small diameter.

Each tool travels the length of its own cut only.

On account of the double adjustment of both turners and turret stops the machine may be interrupted while running on one kind of work, and with the extra stops set for a new piece, it can turn out an entirely different piece without disturbing the adjustment for the first piece; or, if only one extra piece is required, all of the stops may be held out of position without change of adjustment.

DIE CLAIMS

The only interchangeable automatically opening die for turret lathes.

The only die for which each chaser is separately milled by a large free cutting mill.

The only lead controlling die.

The only chaser in which there is an error of only one hardening.

SCREW THREADS

IN the original development of the Turret Lathe for accurate lathe work, the greatest obstacle to our progress was the means formerly employed for cutting and measuring screws.

Die-cut threads were never correct in lead, and seldom of good shape. Lathe-cut or chased threads were found to have an error in lead averaging one-thirty-second of an inch in twelve inches when cut by new lathes, and much greater error when produced by old lathes. On account of errors in lead and shape, neither the die nor lathe-cut screws could be measured.

The so-called screw gauge used would tell how a screw would "feel" in a hole of

the same length as the gauge, but would never tell how it fitted.

The die described has a lead error of less than one-sixty-fourth in eighteen inches; produces a shape of thread accurate beyond measure, making it possible for the first time to measure screw threads by the use of the ordinary micrometer, ring or snap gauge. We believe this marks a most important step in the advancement of accurate machine construction. A full explanation follows, making very clear how such results are obtained.

GENERAL DESCRIPTION

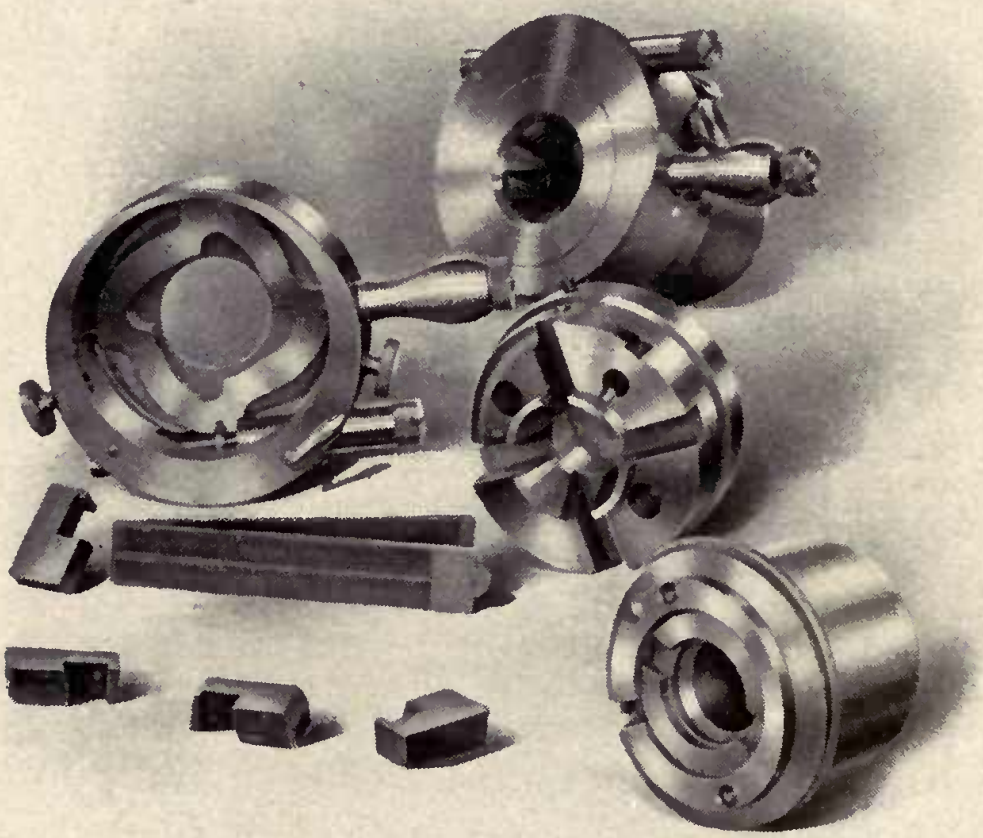
THE Hartness Automatic Die, shown herewith, is supplied in three sizes, viz.: No. 1, for cutting screw threads from $\frac{3}{32}$ inch to ½ inch in diameter; No. 3, for screw threads from ¼ inch to 1¼ inches in diameter; No. 6, for screw threads from 1 inch to 2 inches in diameter, and No. 9 for screw threads from 1½ to 3 inches diameter.

Right or left-hand chasers are supplied as required for cutting United States Standard, Whitworth Standard, V, Acme and pipe threads; also, the various fine threads in customary use. It was designed expressly for the Flat Turret Lathe, but may be used in any of the existing screw machines or turret lathes by change of shank.

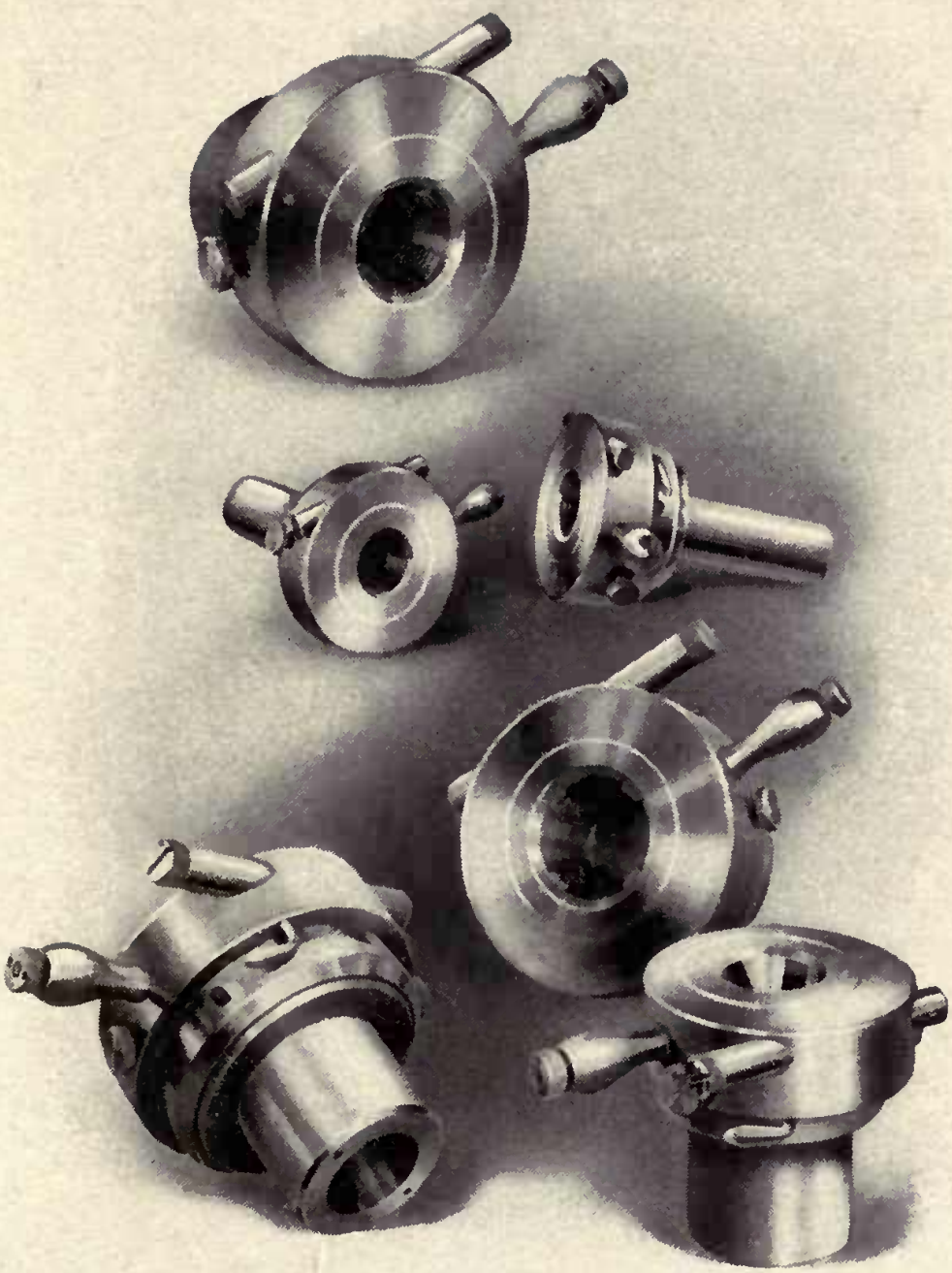
It opens automatically when the travel of its holder or shank is retarded.

The cam for controlling the chasers takes bearing directly over and very close to the cutting strains, hence there is no chance for the chaser to get away from its work by canting or tipping. This insures straight

work, which has seldom been done by other forms of automatic dies. The connection between the shank and the body of the die is a double universal joint allowing the die to assume any position required by the work. This connection remains perfectly flexible under the greatest torsional strain of cutting, and provides a



Hartness Automatic Die and Its Parts



A Group of Hartness Automatic Dies

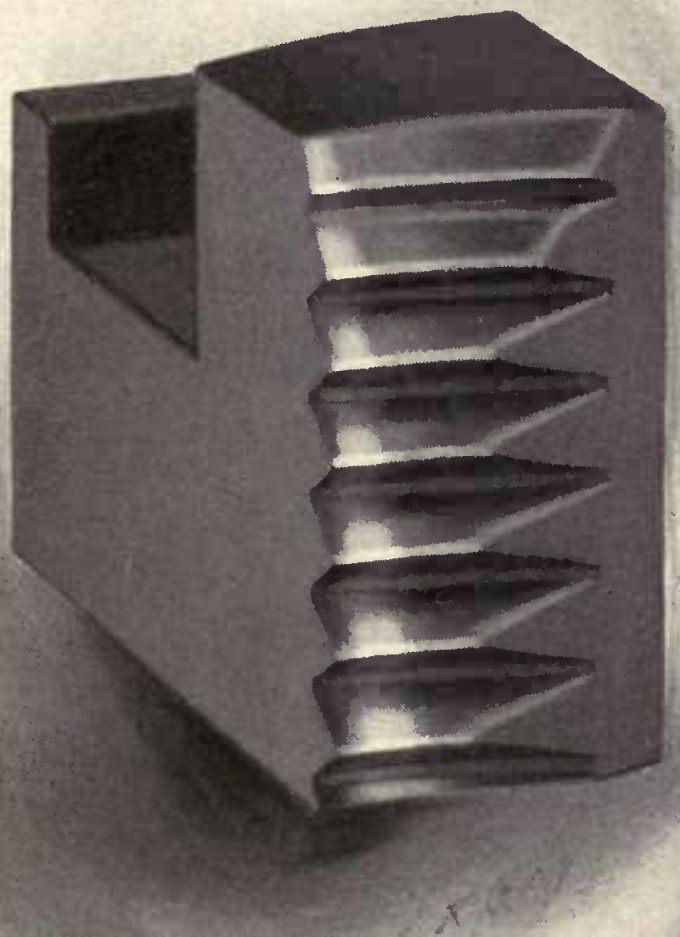
compensation for the slight but important change of alignment that takes place in all turret machines as soon as a die begins to cut.

The latch pin which holds the cam in close adjustment is provided with two latch surfaces, one for a roughing cut and the other for a finishing cut. Turning the latch half way around changes it from one to the other without disturbing the principal adjustment for size. With this feature smooth screw threads can be cut when the lead is very coarse. It is seldom used on standard threads below 1 inch in diameter.

Every part of the die is made either from open-hearth or tool steel, the lathe work being done exclusively on the Flat Turret Lathe, and all other operations by special machinery. It is perfectly interchangeable throughout.

LEAD-CONTROLLING FEATURE

THE process of forming the chaser teeth is such that the front or working teeth have an ideal cutting clearance, while the back teeth have no clearance, but instead take bearing on the work a trifle back of the face of the chaser, forming substantially a lead nut which rides on the thread produced by the front teeth, thus governing the lead of the screw.



These chaser teeth are formed by special milling machines provided with means for recording to a nicety all angles and positions of approach of work to cutters, so that an absolute knowledge of the clearance and contact of each tooth is possessed. Each chaser is milled separately, insuring a perfect interchangeability.

The milling cutters used are 2½ inches in diameter, regardless of the size of the screw to be cut by the chasers. These cutters are formed in backing-off lathes and possess an ideal clearance. When in use the faces of their cutting teeth are ground frequently, thus maintaining the correct degree of rake and a keen cutting edge; they take a clean cut without any of the burnishing or rubbing action which always accompanies the hobbing or tapping of dies. The importance of this feature is appreciated after the dies have returned from the hardening process. Since the metal in the chaser teeth has been undisturbed by the cutting process, and only the extreme

edge hardened, leaving the soft back very near to the edge, no appreciable change of form takes place.

In the process of hardening other dies the compressed or burnished metal—which has been squeezed into shape by the hobbing or tapping action—is quick to assume a more natural position, and this results in a distorted die.

Our method does not depend on the accuracy of the lead screw of a lathe in which hobs, taps and mills for producing dies are made, neither are we affected by the change in hardening of such tools.

All other methods have at least the errors of two hardenings and one lead screw. We correct in the milling machine all errors excepting the final hardening of the chaser, which takes place under such ideal conditions that we cut a practically perfect screw.

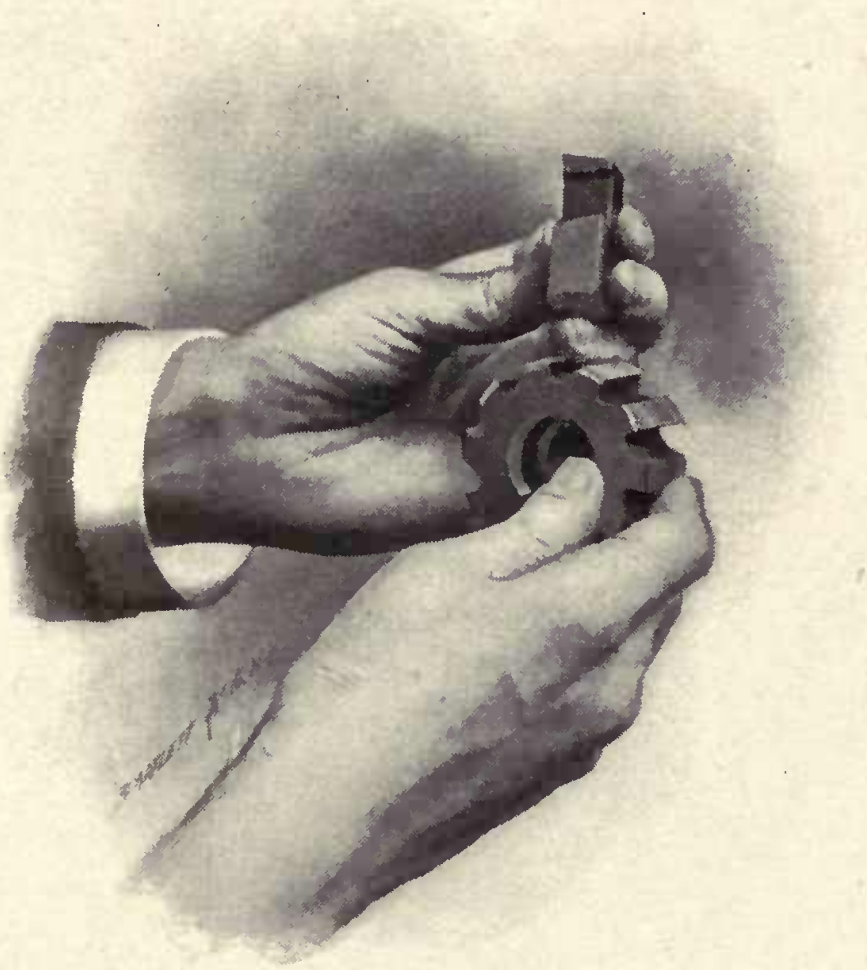
The error in lead is less than $\frac{1}{64}$ in 18 inches in screws of standard pitch, and when cutting threads of fine pitches, a proportionate accuracy of lead is maintained.

To obtain a full appreciation of the comparative minuteness of this error it is only necessary to measure with a good scale the lead of the best taps on the market, the lead screws of engine lathes and the screws cut by other dies, any of which will show errors from four to ten times as great.

In view of these facts we consider our die practically perfect in its lead-controlling features. If greater accuracy of lead is required than that found in our regular stock chasers, we are prepared to furnish, at a special price, chasers having lead errors not exceeding $\frac{3}{1000}$ of an inch in 18 inches.

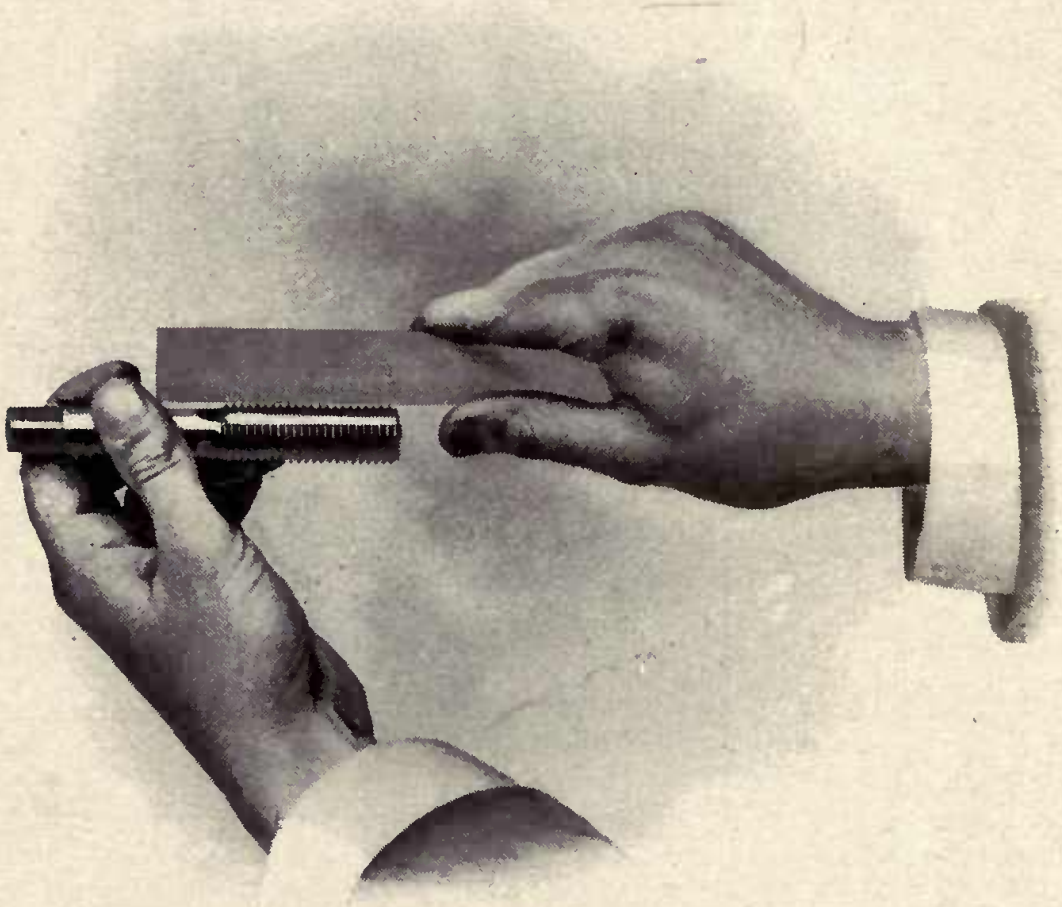
GENERAL DIRECTIONS FOR USING

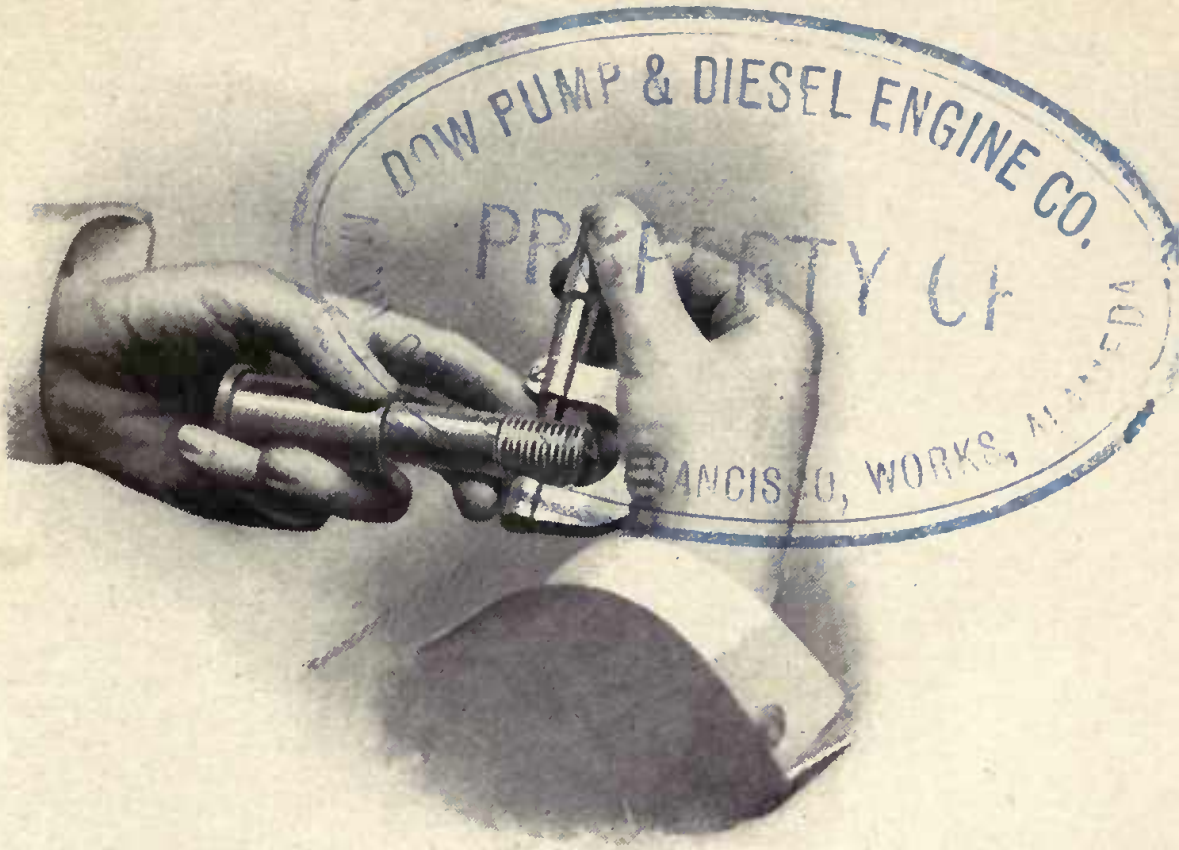
IF the lead of the work produced does not correspond to the nut into which it is fitted, do not condemn the die, but measure the lead of both the work and the taps with a scale, providing you can get both in length of 4 or 6 inches. It is practically impossible to make taps that will lead accurately on account of varying results in



hardening. This element of uncertainty is eliminated in this die, as explained on the two preceding pages. The error in lead of taps is usually so great that it is plainly visible on 1 or 1½ inches of length. A scale placed on tops of teeth will show at the even inches the error, and at the 1½-inch graduations if the pitch is an even number to the inch.

Fifty per cent. of the taps now in use should be discarded When you order new

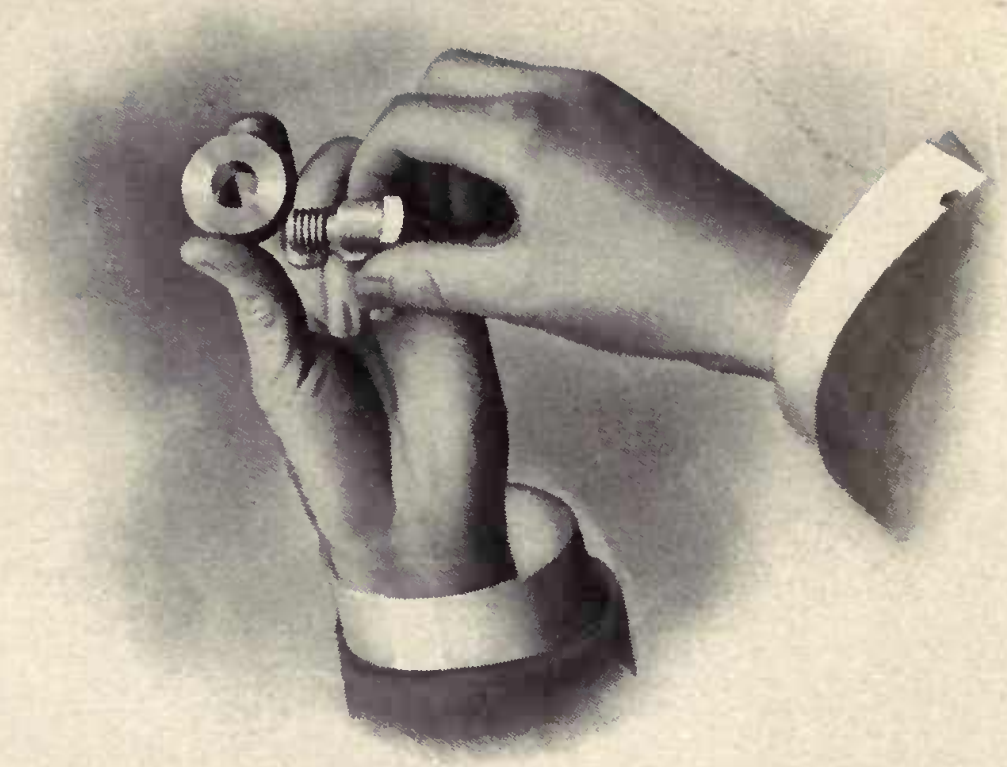



DOW PUMP & DIESEL ENGINE CO.
PROPERTY OF
SAN FRANCISCO, WORKS, ALAMEDA

taps ask the maker to select taps of good lead, and if necessary pay an extra price for getting the cream. It will be worth it if you want good work. Measure the diameter of the taps and see that there are no burrs or fins in bottom of thread to spoil shape of thread in the work.

The so called thread gauges, in the form of a circular nut, though nicely finished and hardened pieces of steel with an internal thread, are very misleading.

All that has been said in the foregoing regarding the impossibility of making correct



lead dies is equally true of these gauges. Furthermore, such gauges wear in directions for which an adjustment cannot be made. A more unreliable gauge could hardly be invented.

The three distinct dimensions of a screw thread should be measured separately. The shape and lead should be measured when the die is made; in other words, the die should cut a correct shape and lead; then the third dimension, the diameter, should be measured when the die commences on a lot of screws, and occasionally thereafter. The thread may be measured by the ordinary

micrometer, snap or ring gauge, taking the diameter at the top of the thread.

As the die becomes badly worn, the lead should be measured occasionally. This can be done by cutting a thread 6 or 12 inches long and measuring it with a good scale, remembering that all scales may "look alike" and yet not be the same in length; hence get a good scale.

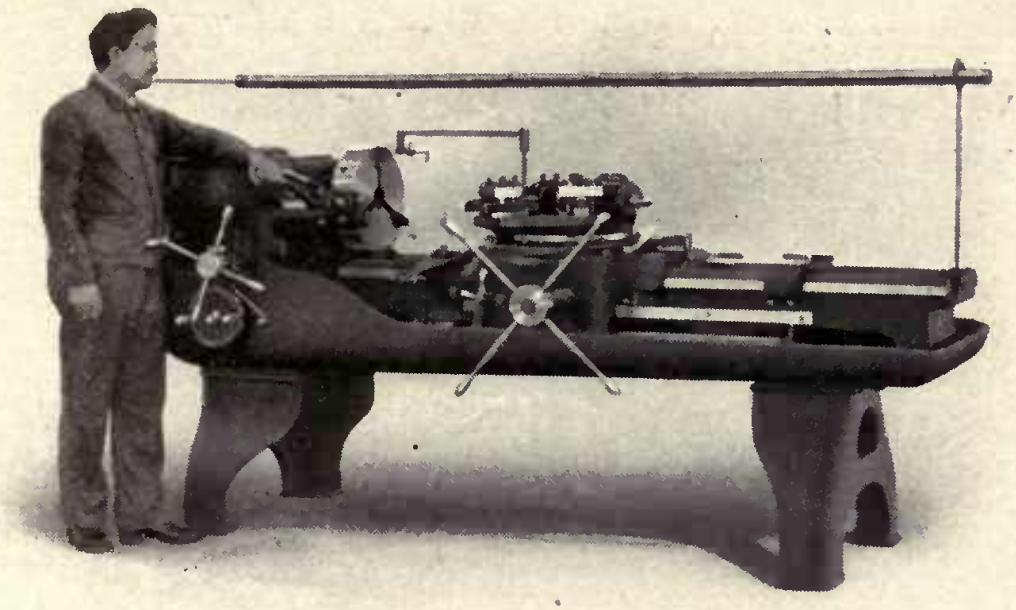
The various forms of screw lead-measuring devices may be used with economy of time and material, but such gauges should be handled with special care and occasionally compared by the foregoing method.

THE FLAT TURRET CHUCKING LATHE

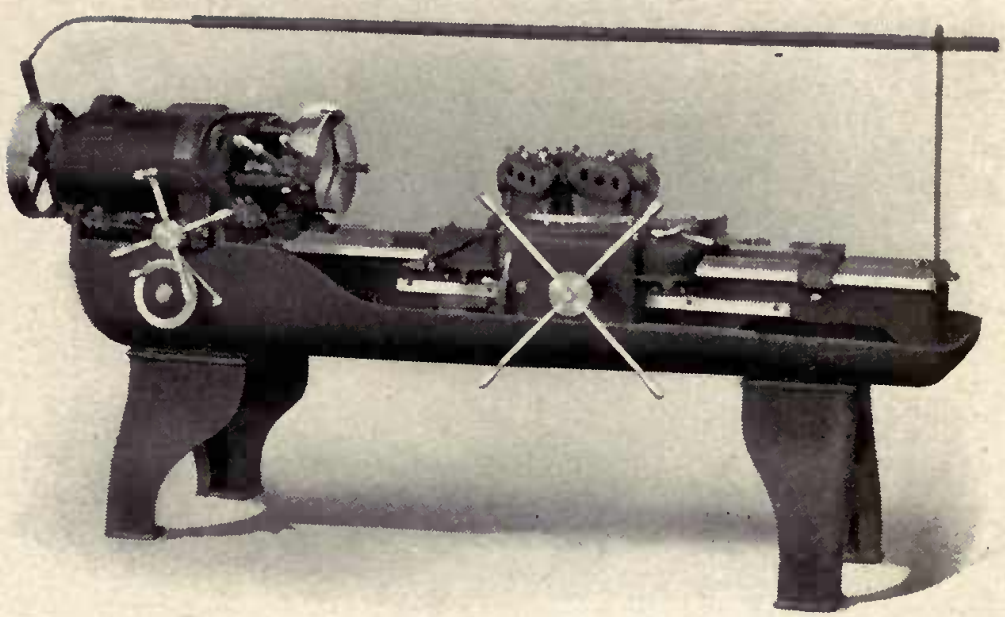
JUST as the original Flat Turret Lathe was the first machine to be equipped with an outfit of conveniently adjustable tools for bar work, so now with the present machine we have provided a universal outfit of tools for chuck work.

The many illustrations of chucking tools and conditions under which they work will carry conviction that we have not fallen short of our established record, to use only the most practical and efficient tools held under the most rigid control and in conveniently adjustable holders. When we say chuck work, we do not

mean merely the process of boring a rough hole in a piece of work to be reamed elsewhere and after that to be pushed on an arbor and turned in some other machine, but we mean finishing the work shown by our accompanying sketches, in which every possible cut is taken that can be taken, and still leave means for holding the piece.



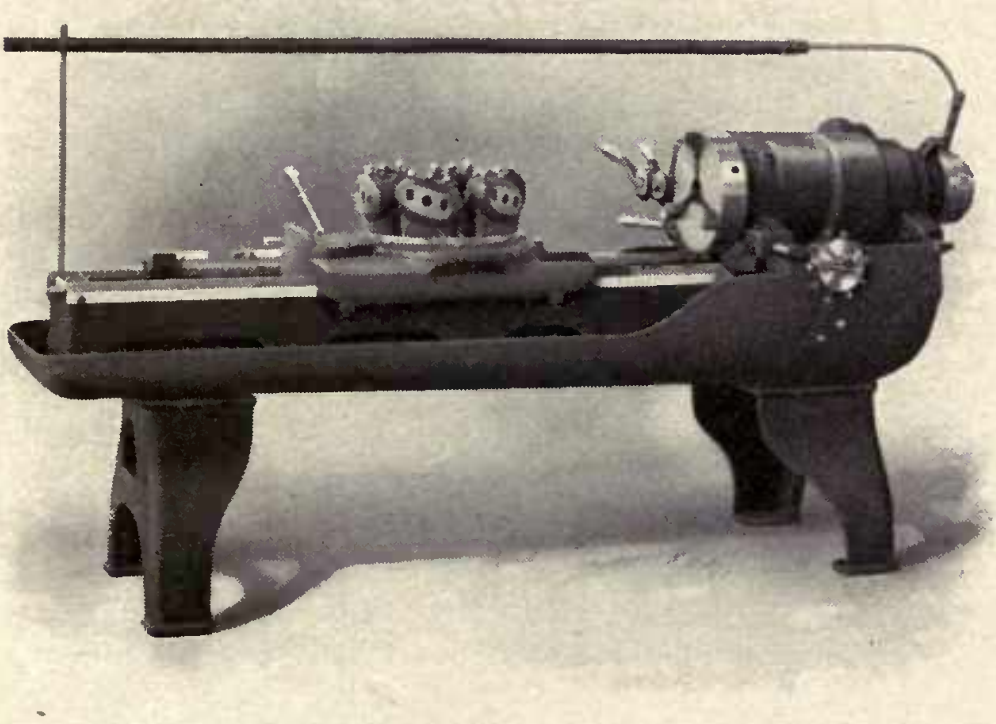
Front View of the 14-inch Swing Flat Turret Chucking Lathe with Cross-feeding Head. This same machine with automatic chuck and roller feed and tools for bar work is called the 3 x 36-inch. When our 2 x 24-inch Flat Turret Lathe is equipped for chucking, it is called the 12-inch Flat Turret Chucking Lathe with Cross-feeding Head



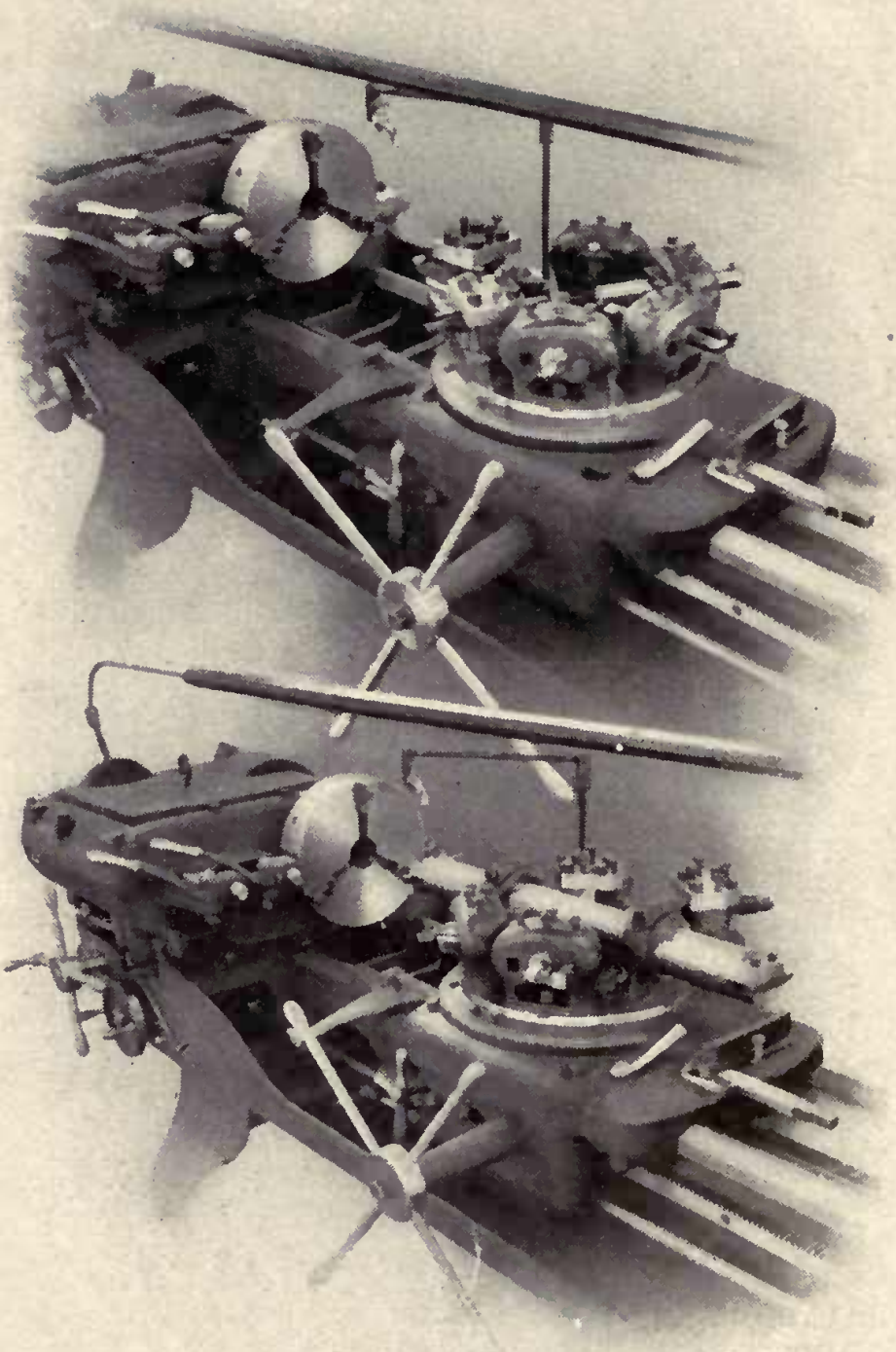
Just as in the past we restricted our working dimensions to a 2-inch spindle hole, so now in this machine we restrict our chucking swing to 12 and 14 inches; but in doing so, we furnish a machine that cannot be equaled by any other machine.

The simplicity of our entire scheme makes it possible to retain for our entire range of work our claim made for the original machine, viz., we can make one piece quicker than it is possible to make it in an engine lathe, and if two pieces or more are required our systems of stops make a convenient and quick means for accurate duplication.

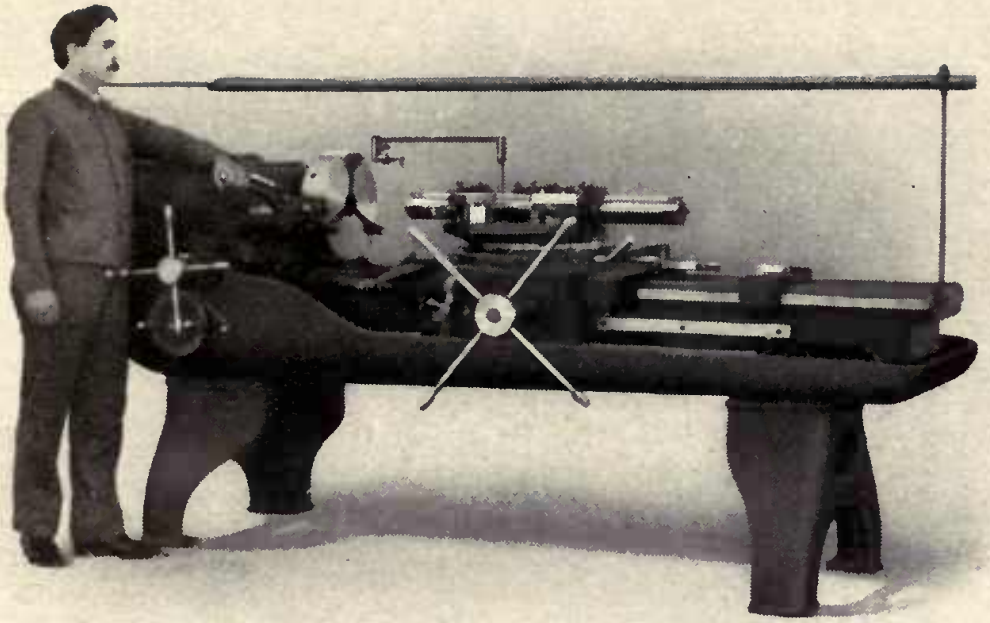
The ten stops for the cross-feed head, combined with the dozen stops for the turret, and the turning and boring tools, all of the simplest and stiffest construction, make this machine ready to begin work as soon as it is supplied with the driving power. It is not only ready to begin work on the work for which it may have been purchased, but



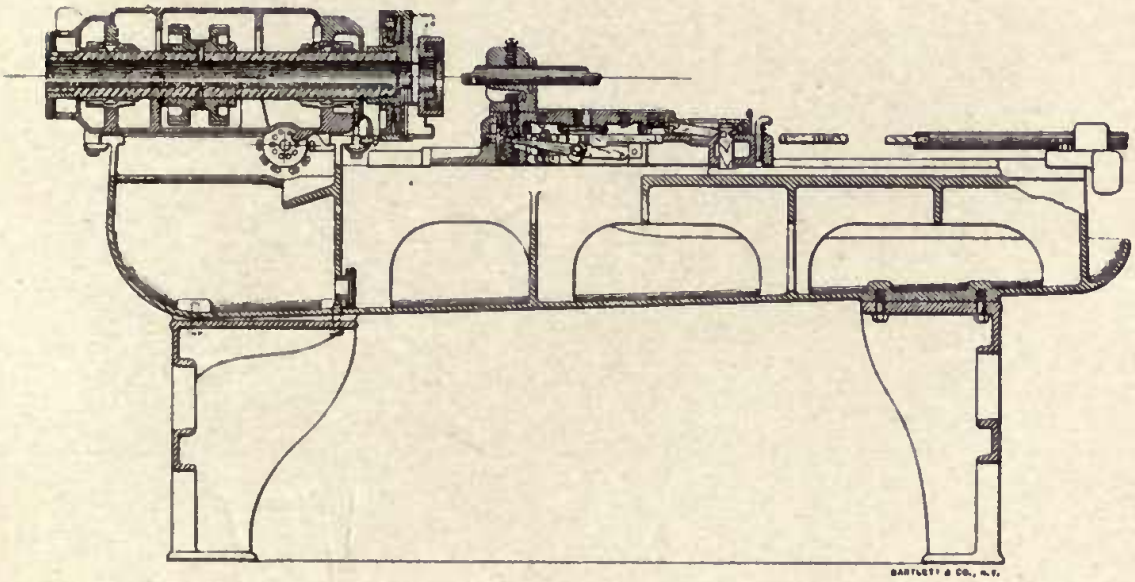
Back View of the 14-inch Swing Flat Turret Chucking Lathe with Cross-feeding Head. This same machine with automatic chuck and roller feed and tools for bar work is called the 3 x 36-inch. When our 2 x 24-inch Flat Turret Lathe is equipped for chucking, it is called the 12-inch Flat Turret Chucking Lathe with Cross-feeding Head.



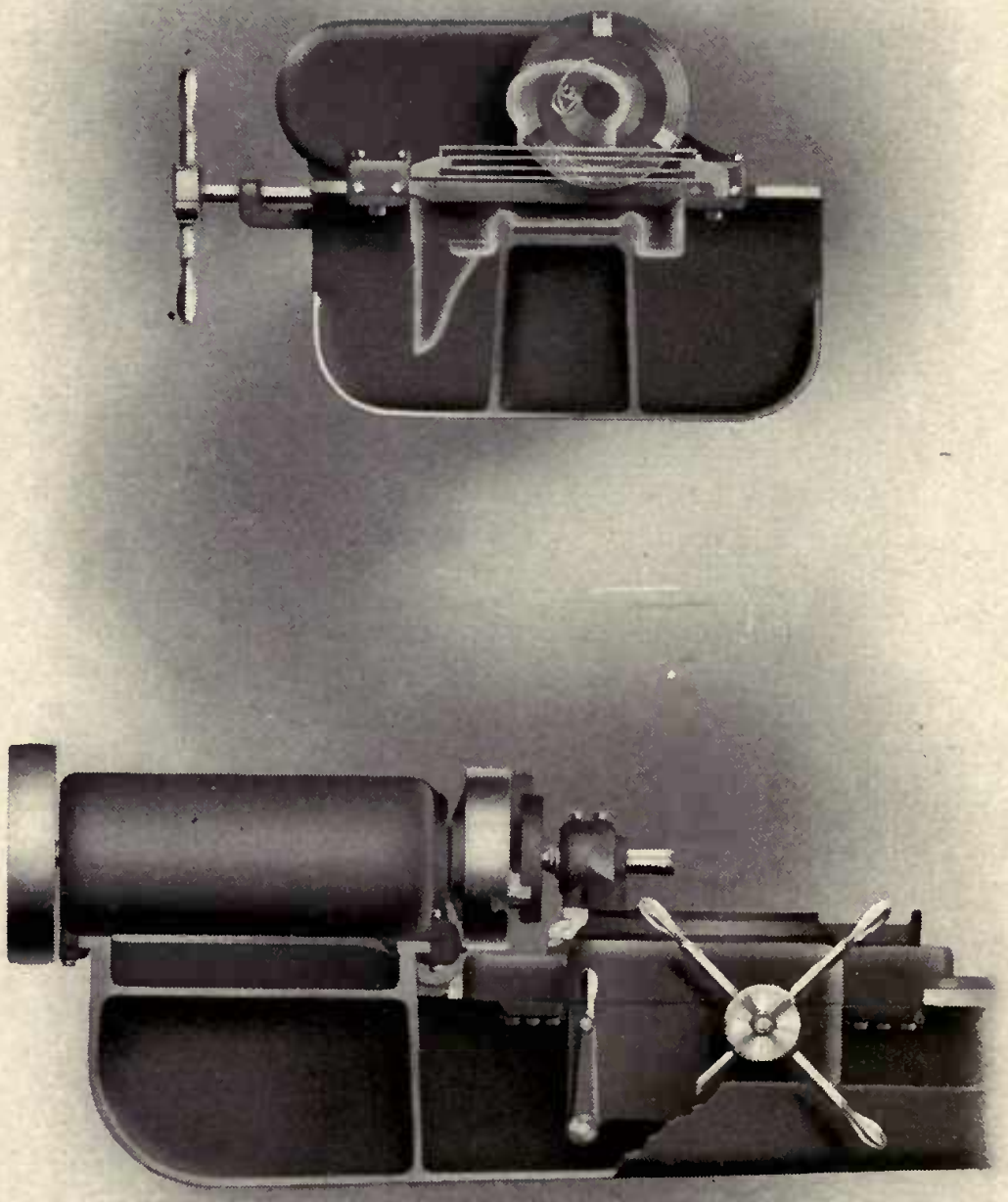
Front Views of Turret with Chucking Outfit Tools in Position



Showing Large Boring Bar



2 x 24-inch Flat Turret Lathe (12-inch Chucking Machine)
Showing a piece of work in the chuck and one of the
boring tools in a holder on the turret

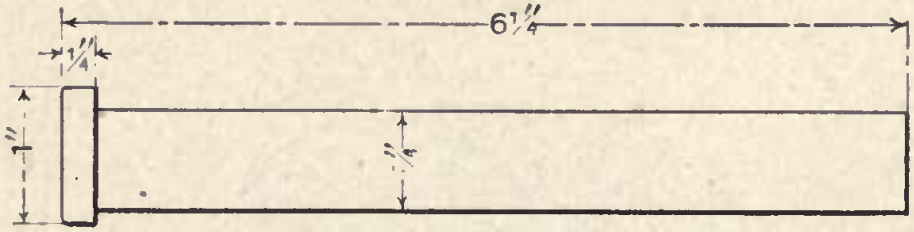


Showing Stability of Work and Tool Control

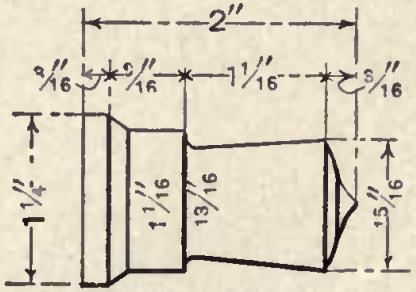
it is supplied with a set of tools that will take care of any similar piece any hour or any day in the future; and, notwithstanding this universality, adaptability and efficiency, our tools and work are brought together under the most rigid control and under ideal conditions never before attained in a lathe.

All the shears and running surfaces are protected from the dust of cast-iron, so that the machine may be used for either steel work in which oil is used, or for cast-iron chucking.

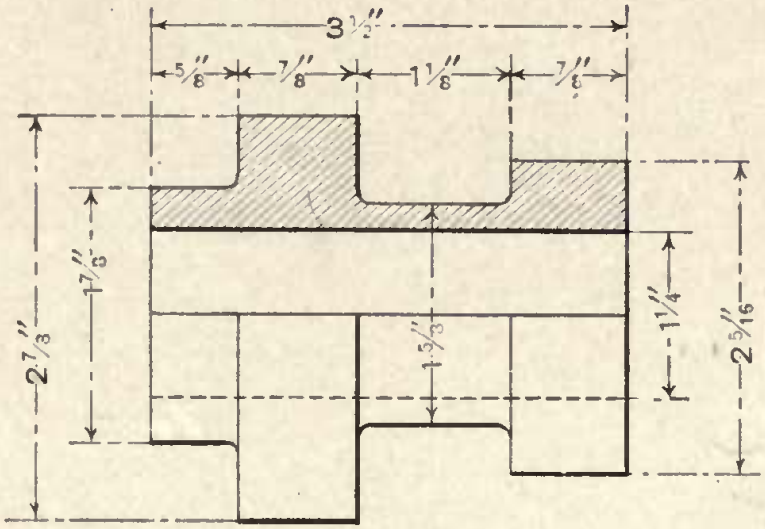
The drawings on pages 140 to 189, inclusive, are intended to show some of the results of giving the lathe head stock a cross travel. For compactness the work is shown at each turret tool, but it will be understood that the turret turns to present each tool to the work and that the travel of the turret carriage lengthwise, combined with the cross travel of the work-carrying head stock and the turning of the turret, bring all the necessary changes of position of work and tools.



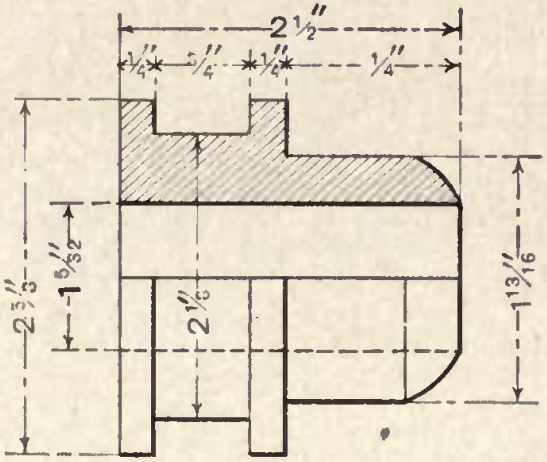
MACHINE STEEL
FINISHED IN 7 MINUTES



TOOL STEEL
FINISHED IN 4 MINUTES

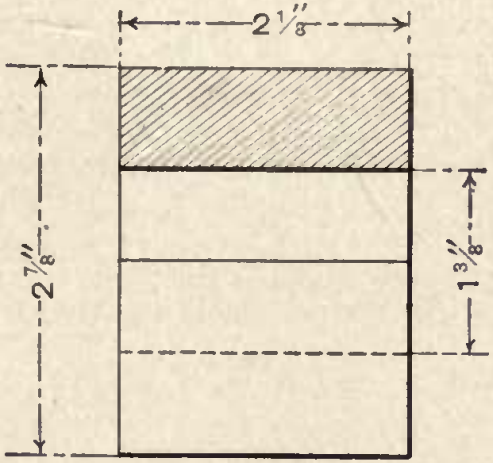


MACHINE STEEL
FINISHED IN 24 MINUTES

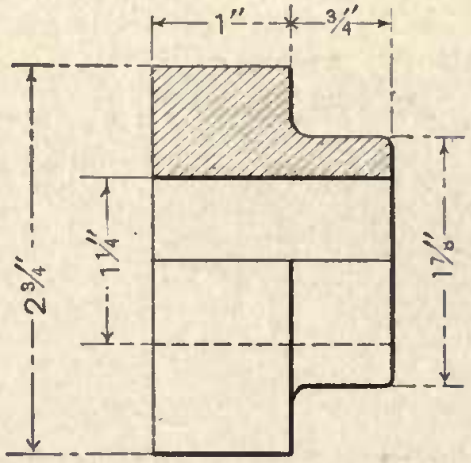


MACHINE STEEL
FINISHED IN 20 MINUTES

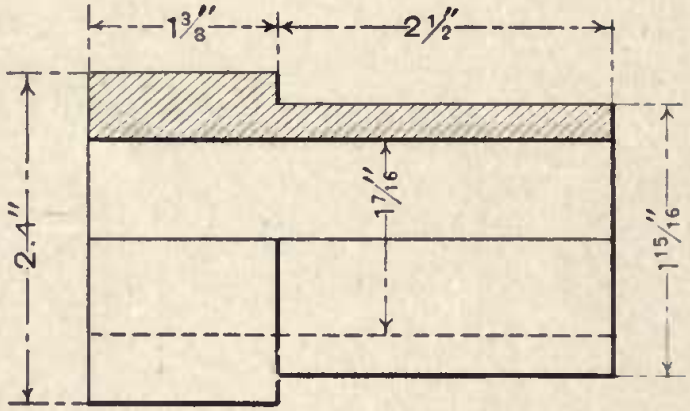
Finished from Bar in One Operation



MACHINE STEEL
FINISHED IN 14 MINUTES

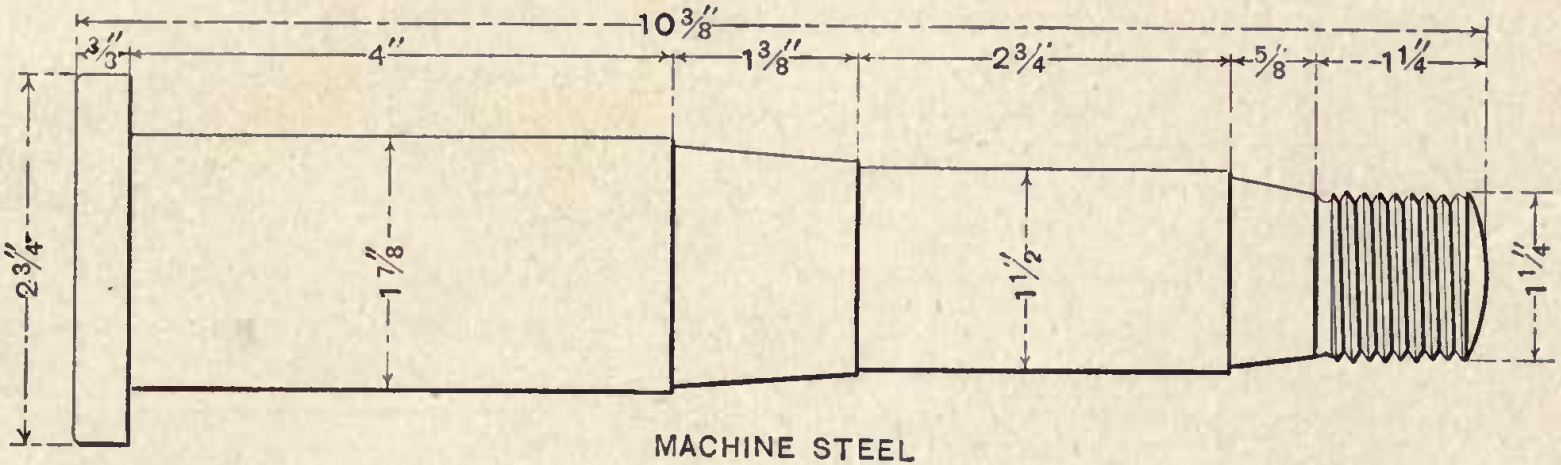


MACHINE STEEL
FINISHED IN 14 MINUTES

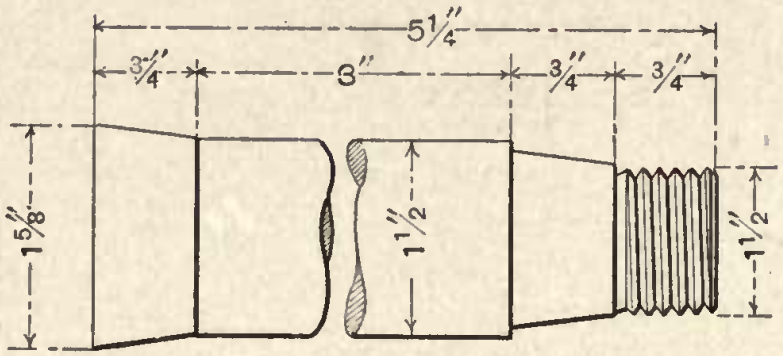


MACHINE STEEL
FINISHED IN 18 MINUTES

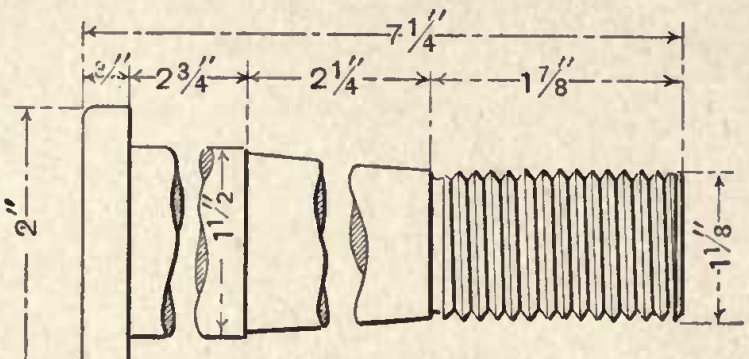
Finished from Bar in One Operation



MACHINE STEEL
FINISHED IN 30 MINUTES

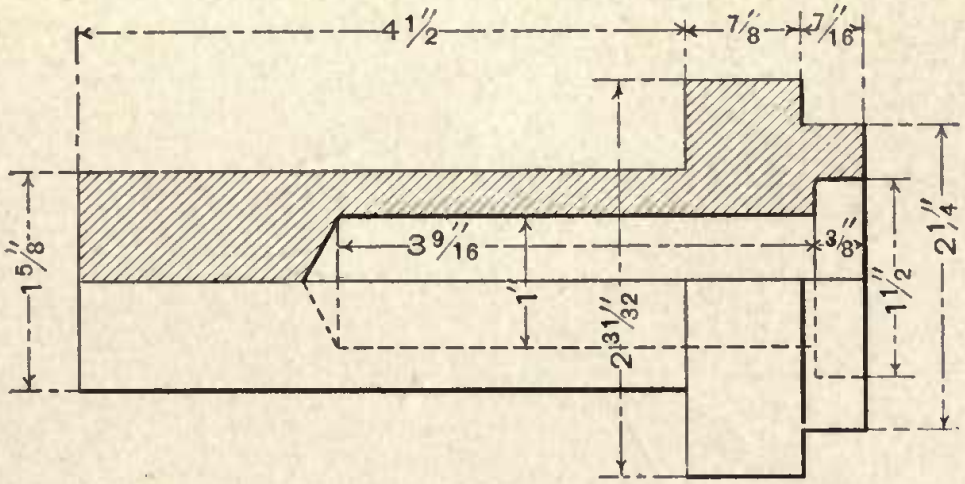


MACHINE STEEL
FINISHED IN 15 MINUTES



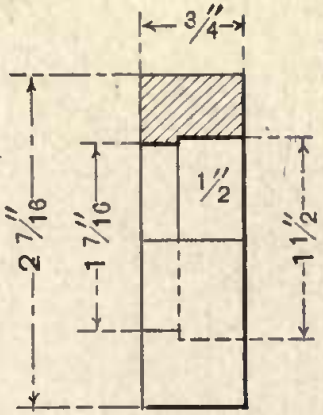
MACHINE STEEL
FINISHED IN 18 MINUTES

Finished from Bar in One Operation

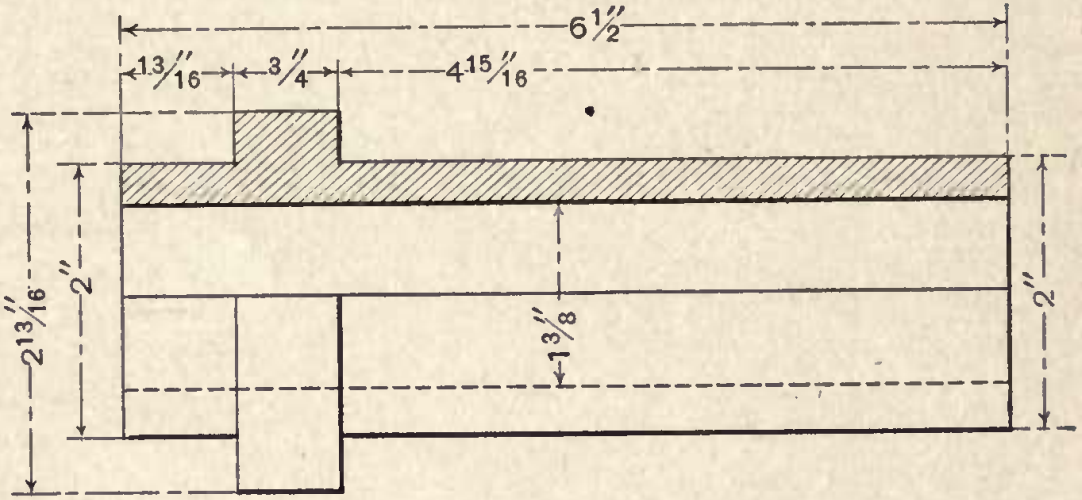


MACHINE STEEL
FINISHED IN 38 MINUTES

Finished from Bar in Two Operations

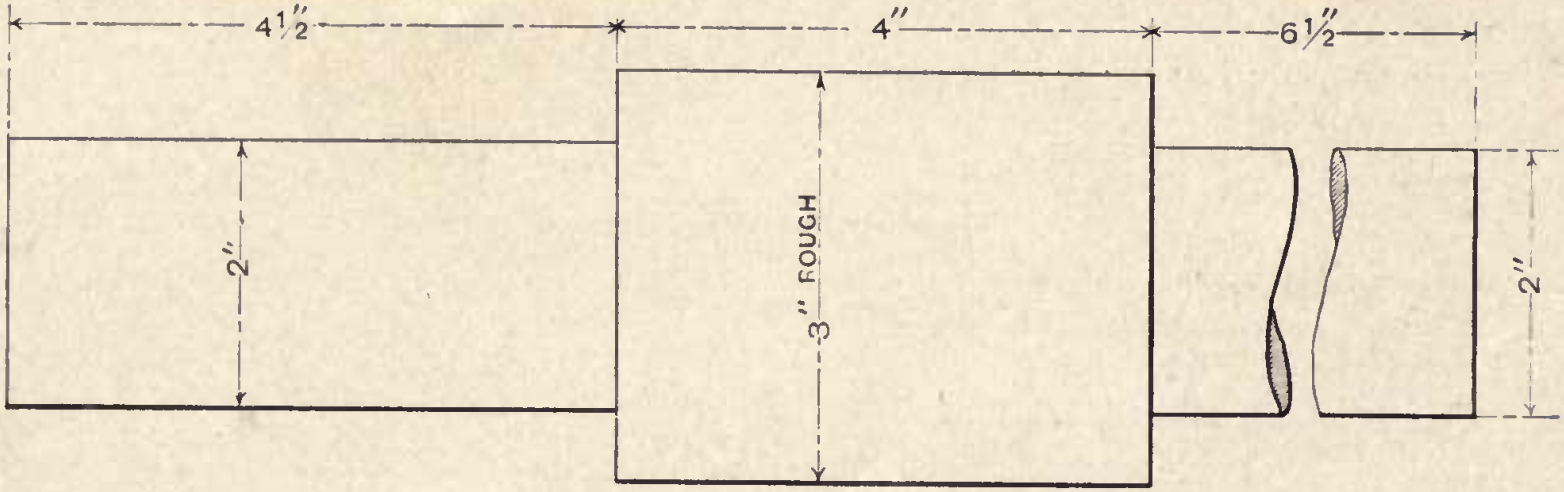


MACHINE STEEL
FINISHED IN 8 MINUTES

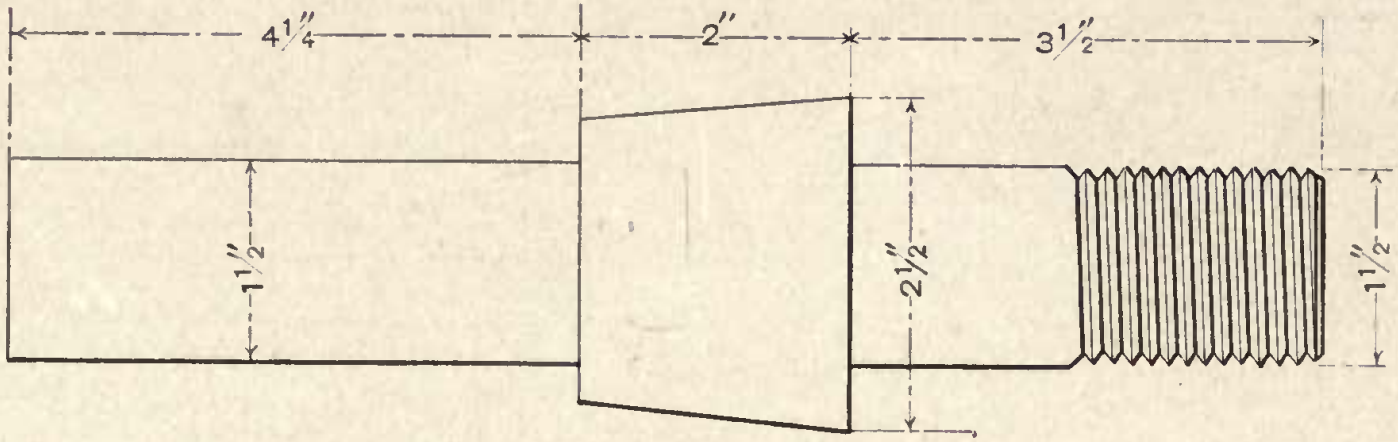


MACHINE STEEL
FINISHED IN 36 MINUTES

Finished from Bar in One Operation

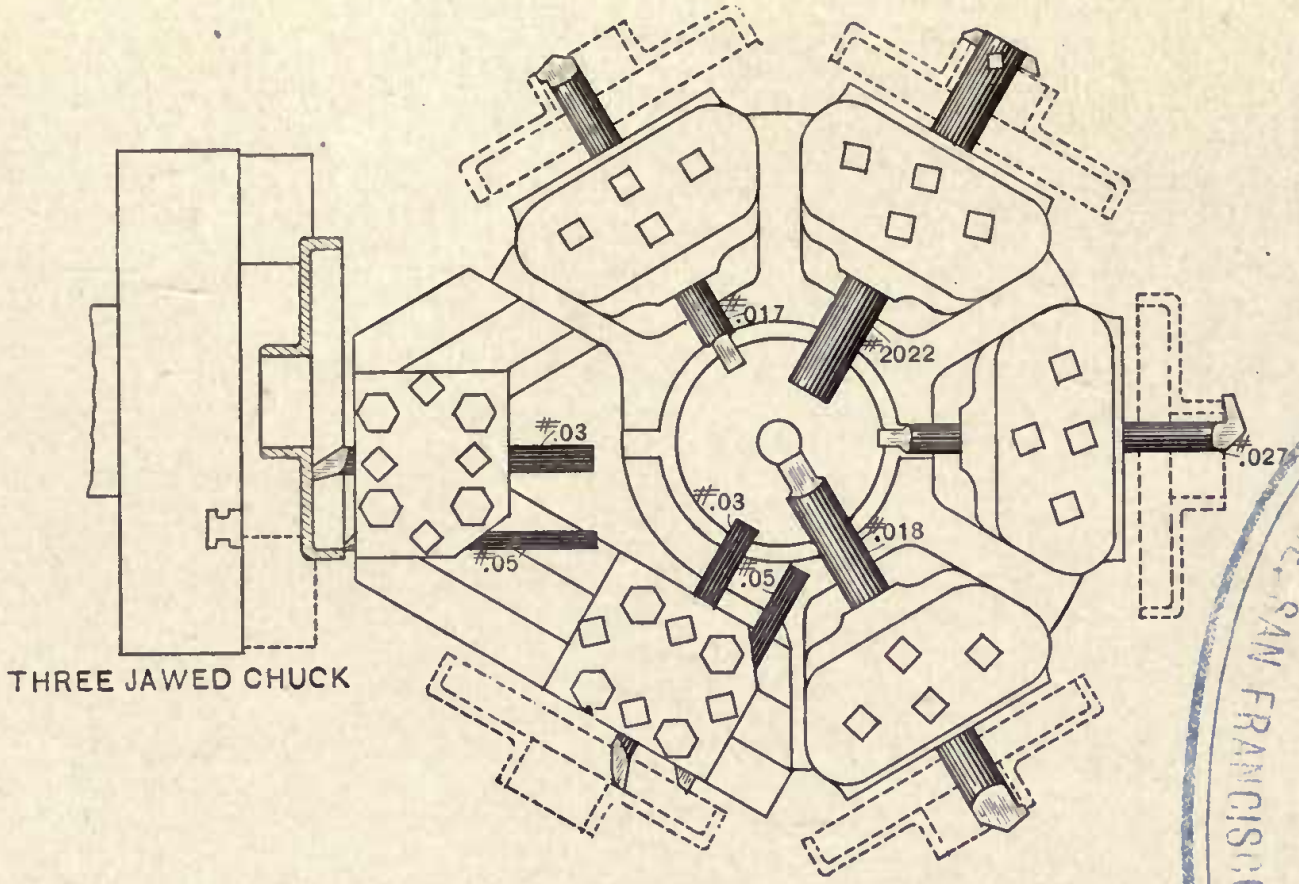


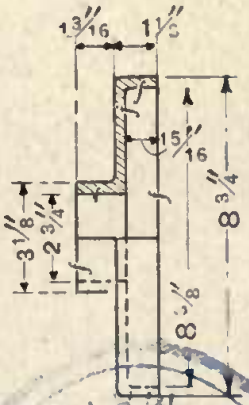
MACHINE STEEL
FINISHED IN 30 MINUTES



MACHINE STEEL
FINISHED IN 33 MINUTES

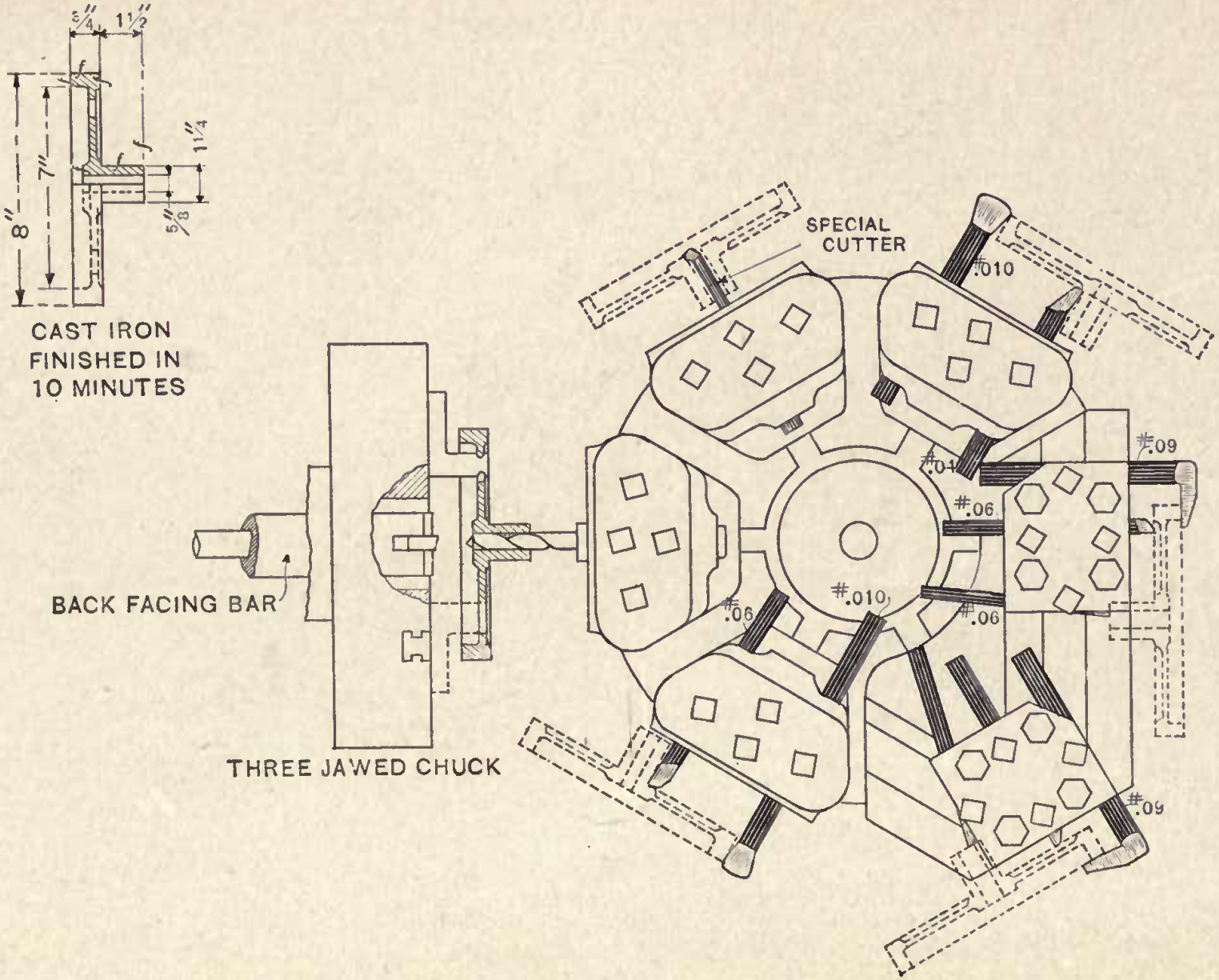
Finished from Bar in Two Operations



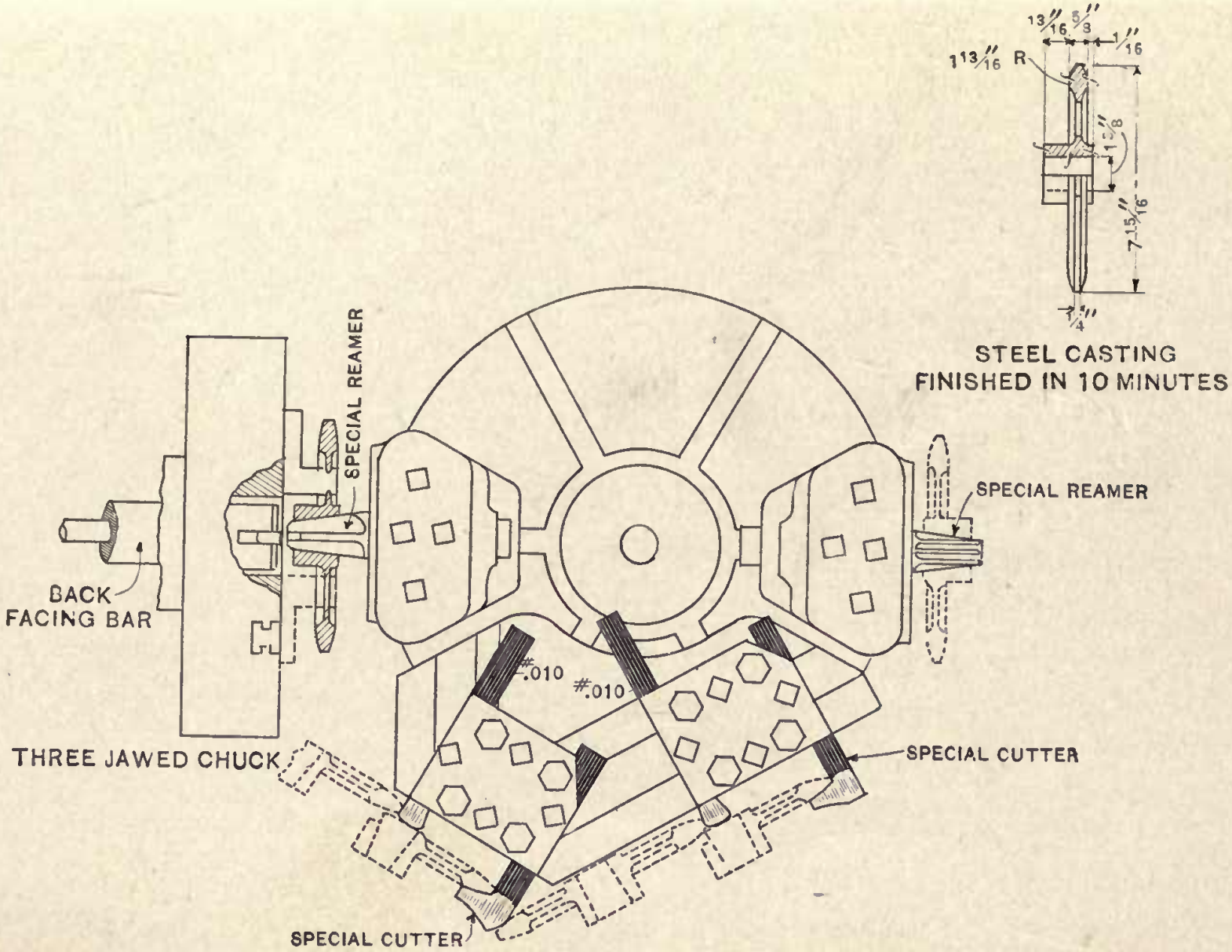


Finished in One Operation

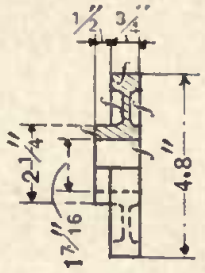
DOW PUMP & DIESEL ENGINE CO.
PROPERTY OF
SAN FRANCISCO, WORKS, ALAMEDA



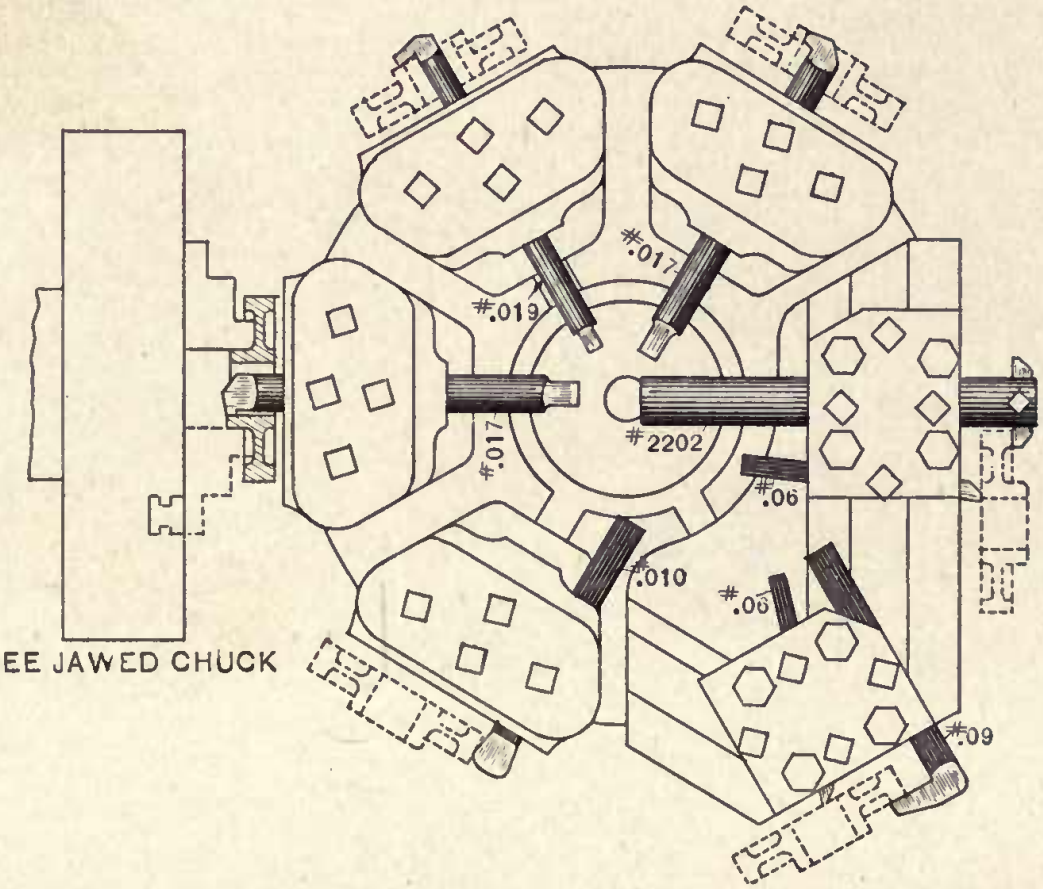
Finished in One Operation



Finished in One Operation

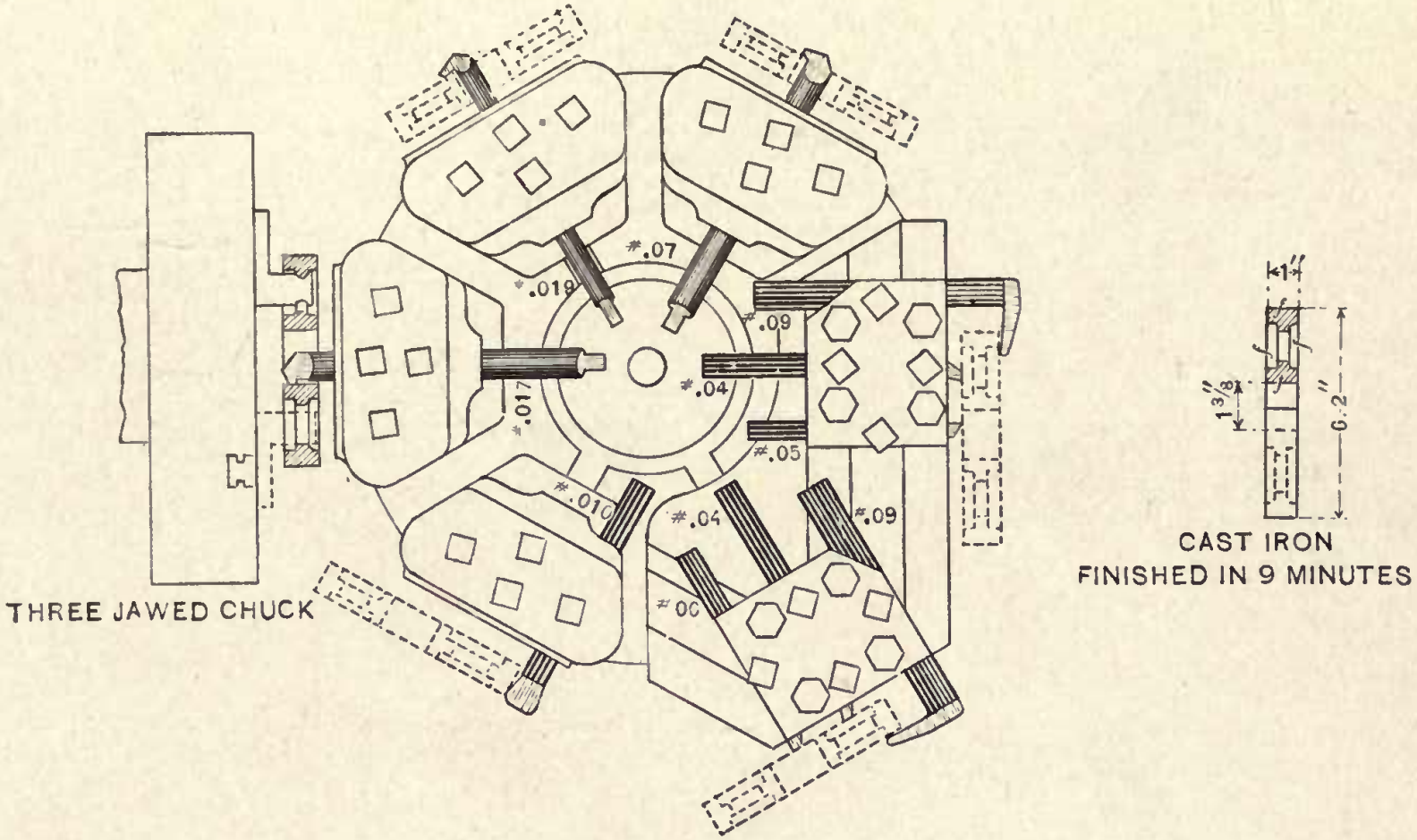


CAST IRON
FINISHED IN 8 MINUTES

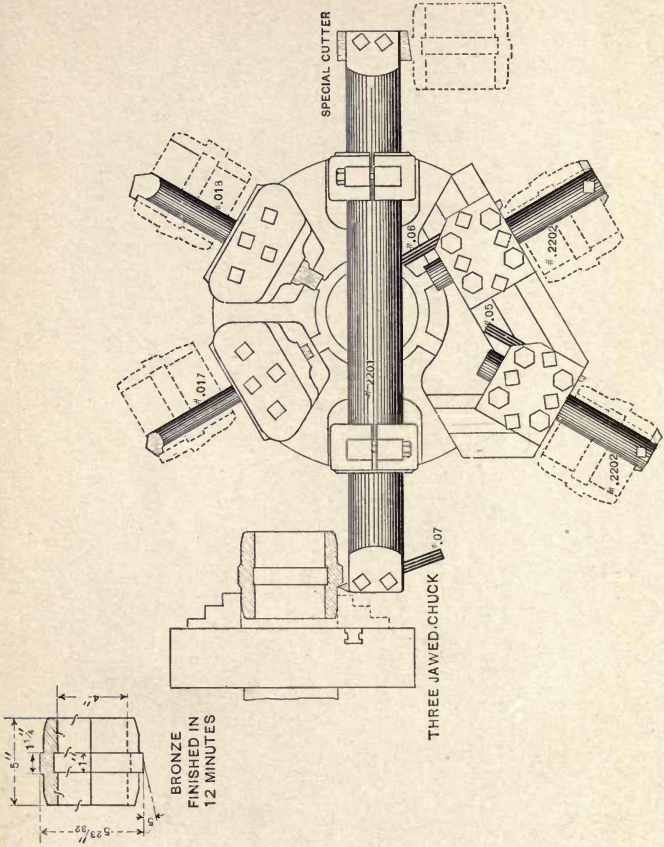


THREE JAWED CHUCK

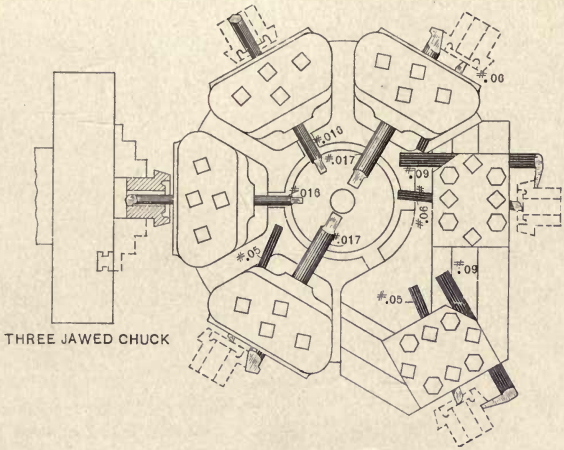
Finished in One Operation

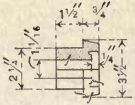


Finished in One Operation



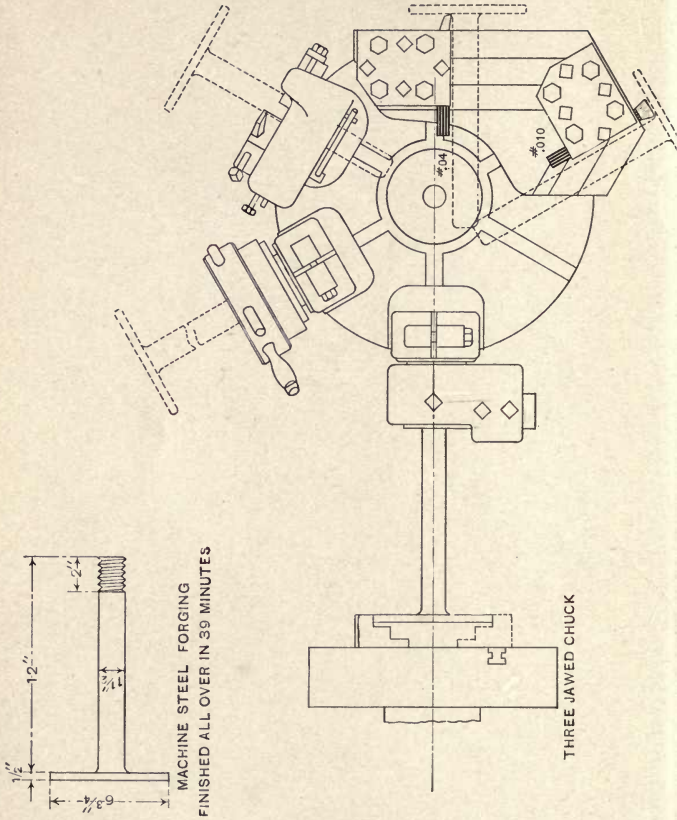
Finished in One Operation



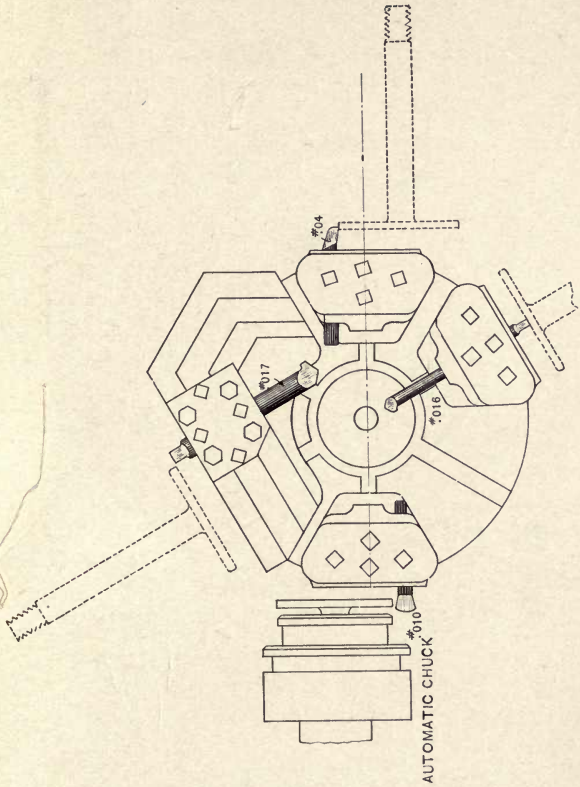


CAST IRON
FINISHED IN 8 MINUTES

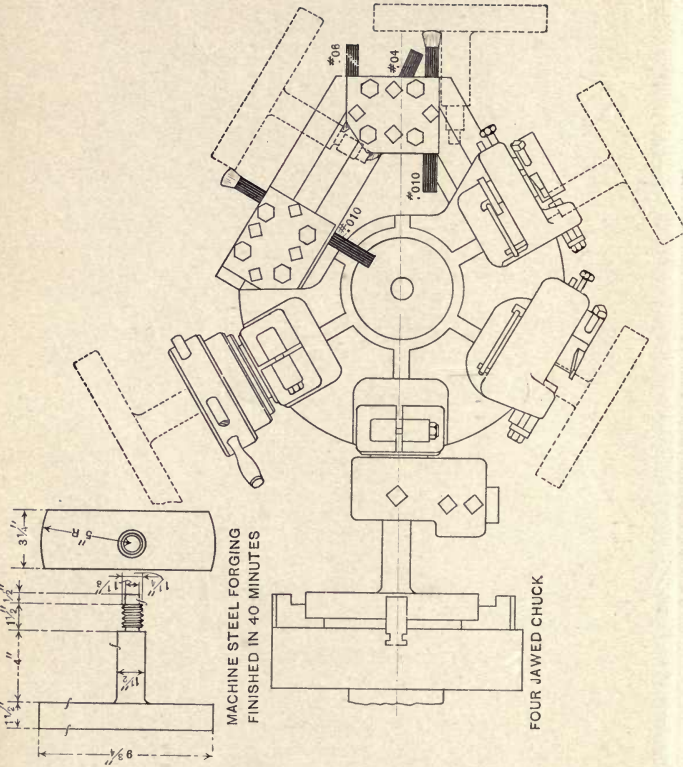
Finished in One Operation



Finished in Two Operations—First Operation



Finished in Two Operations—Second Operation



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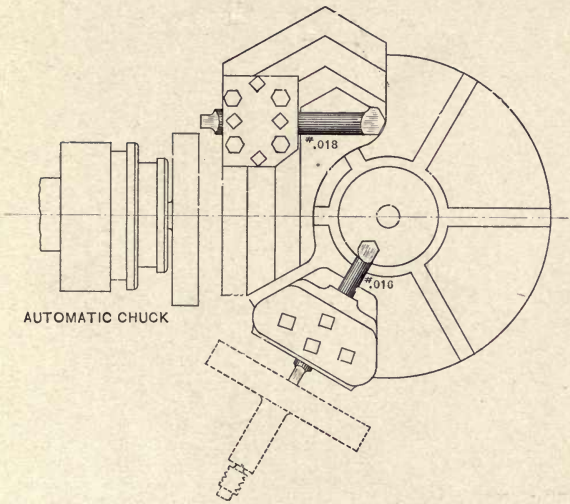

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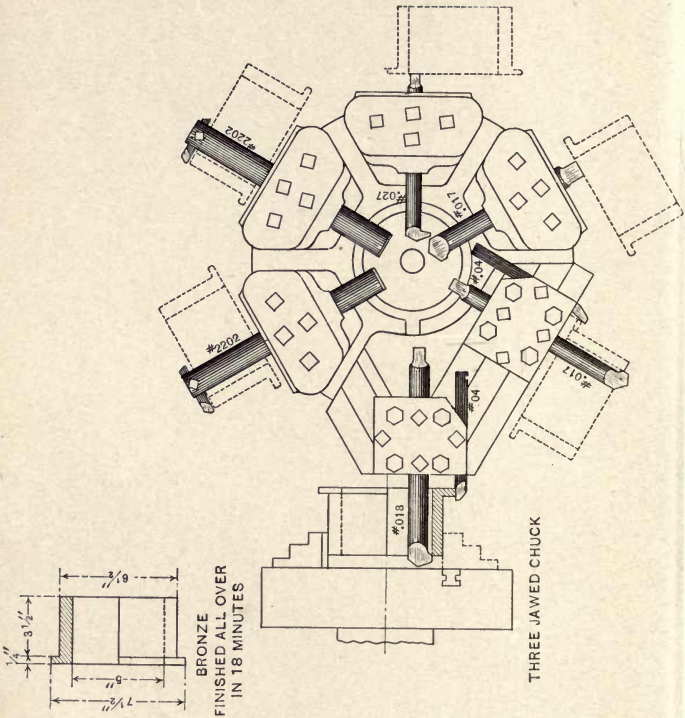

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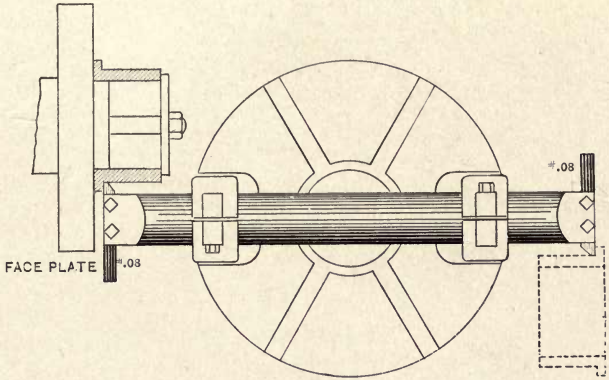

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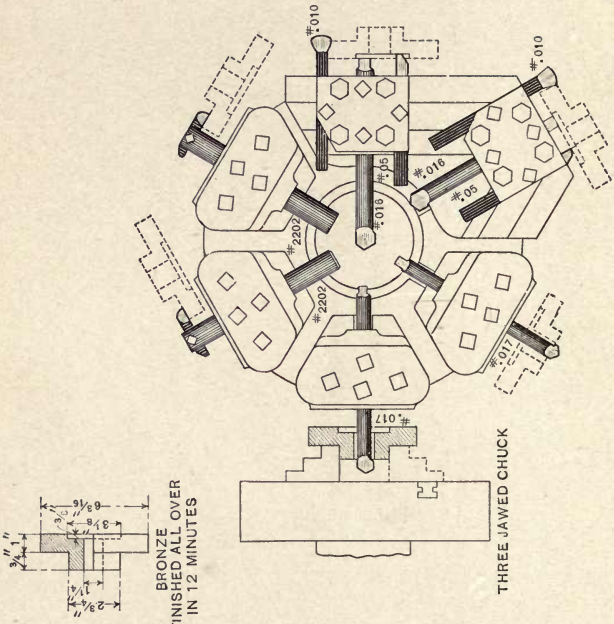

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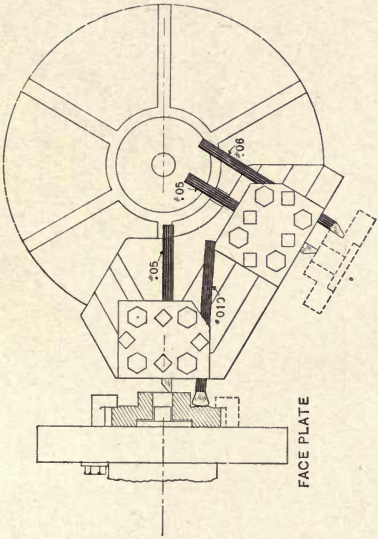

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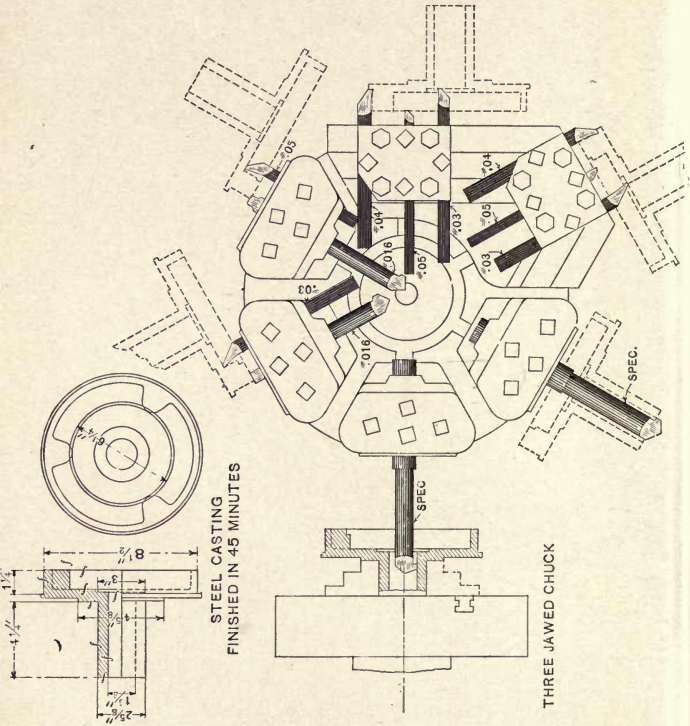

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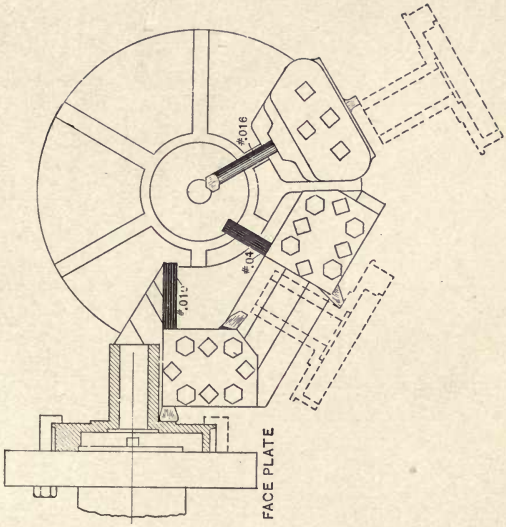
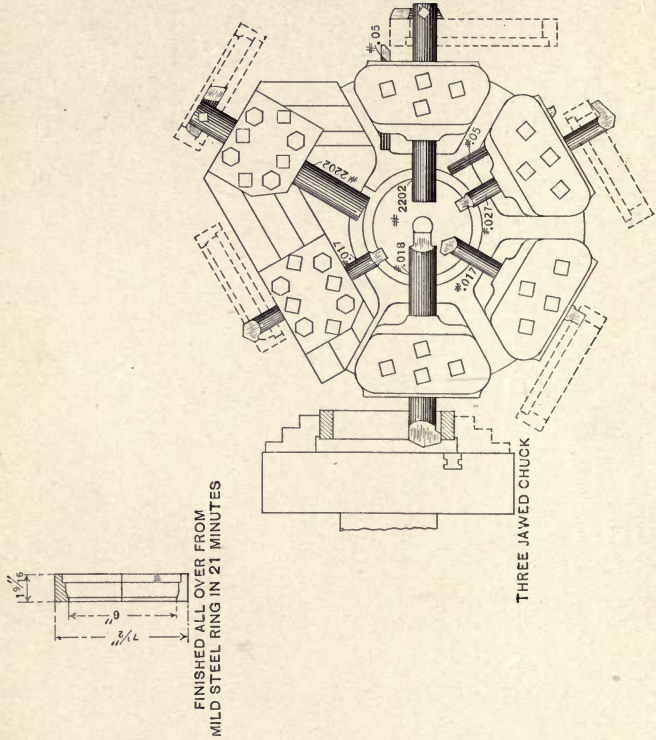
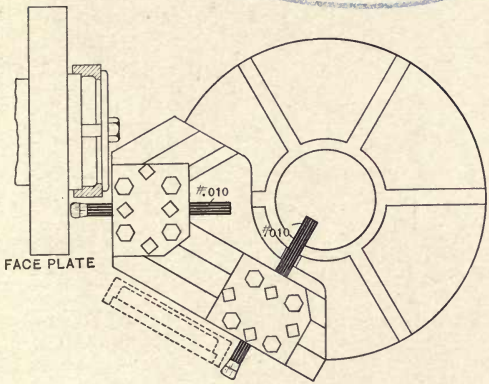


Finished in Two Operations—Second Operation

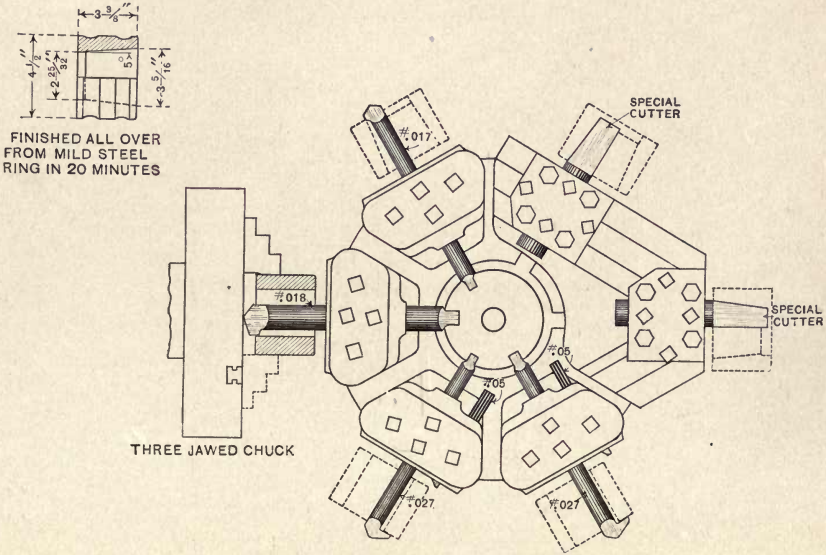


Finished in Two Operations—First Operation

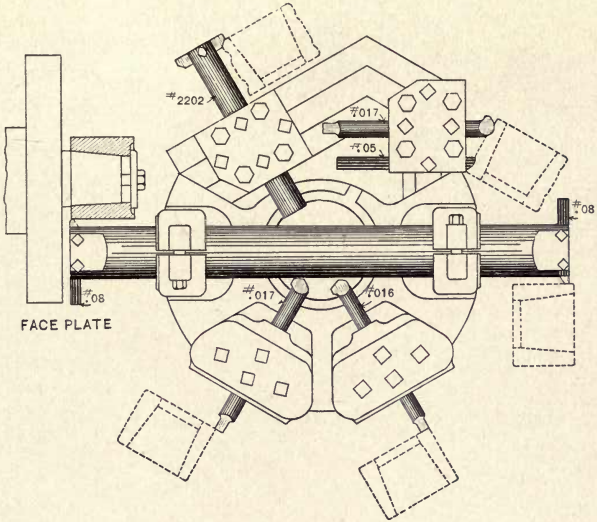
DOW PUMP & DIESEL ENGINE CO.
PROPERTY OF
MAIN OFFICE, SAN FRANCISCO, WORKS, ALAMEDA



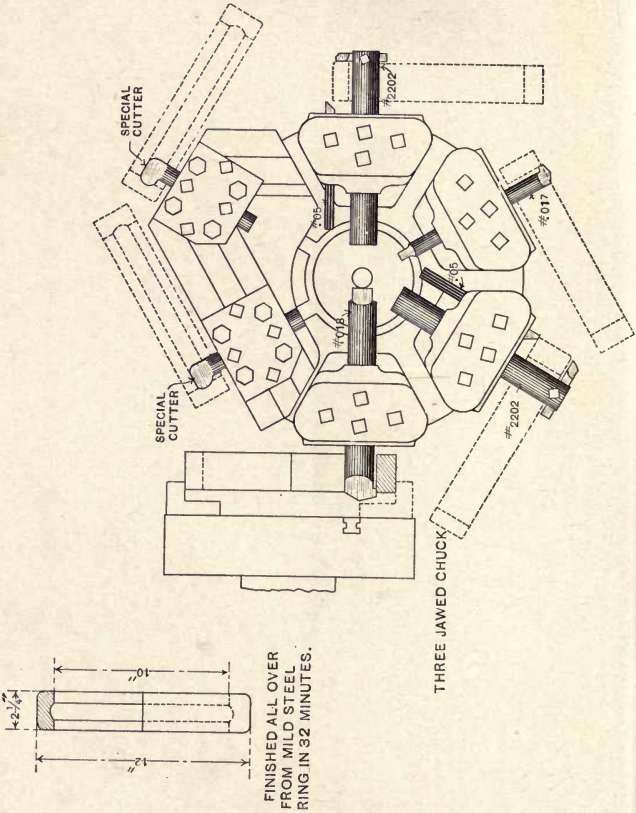
Finished in Two Operations—Second Operation



Finished in Two Operations—First Operation



Finished in Two Operations—Second Operation



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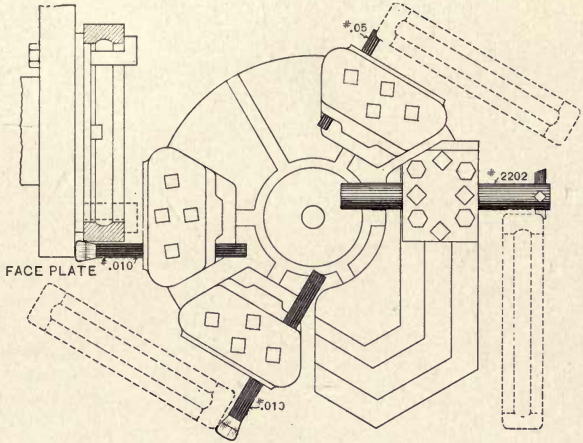

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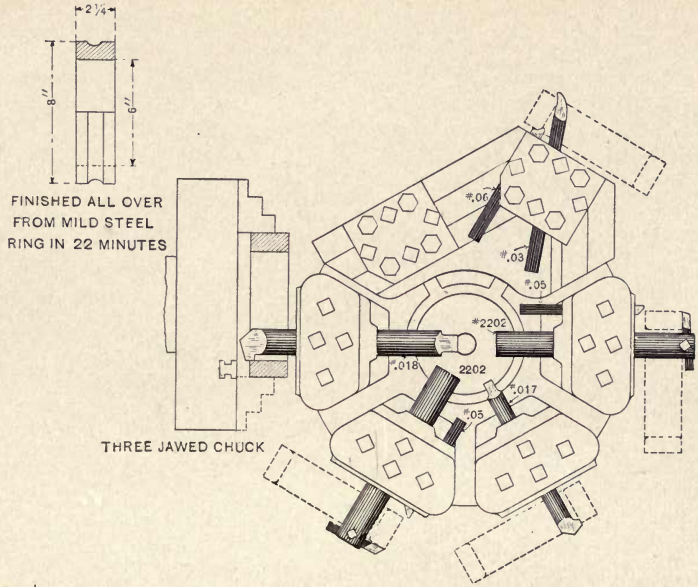

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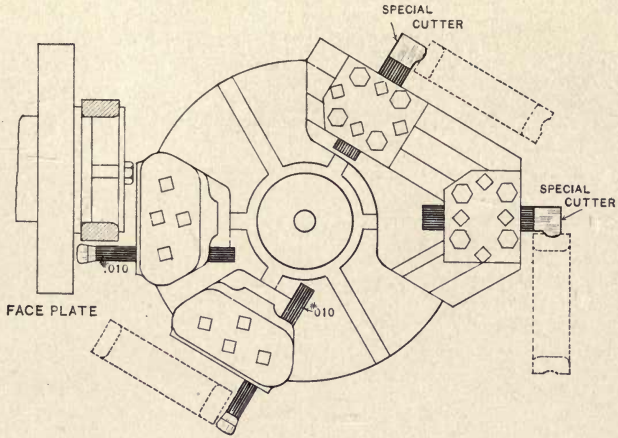
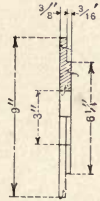
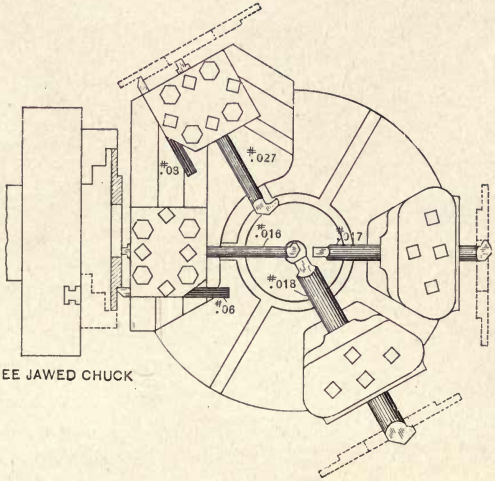


Finished in Two Operations—Second Operation

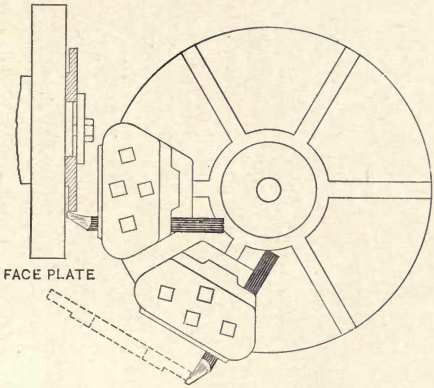


STEEL CASTING
FINISHED IN 20 MINUTES

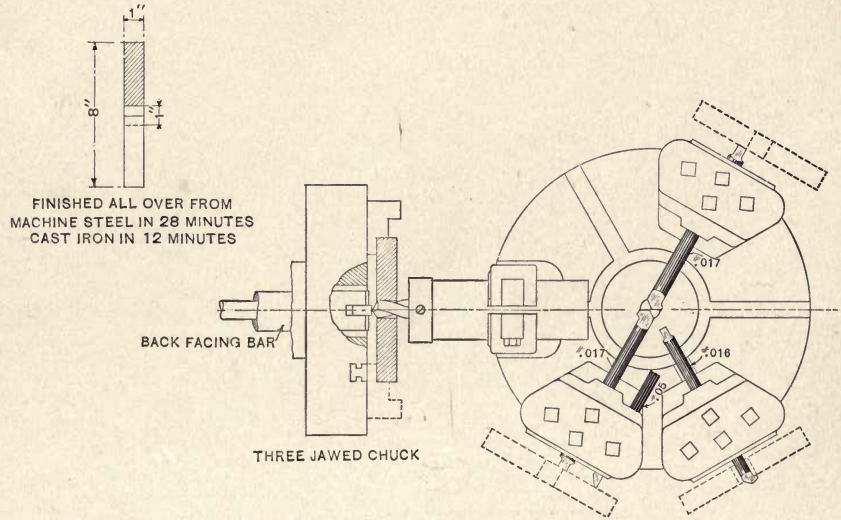


THREE JAWED CHUCK

Finished in Two Operations—First Operation

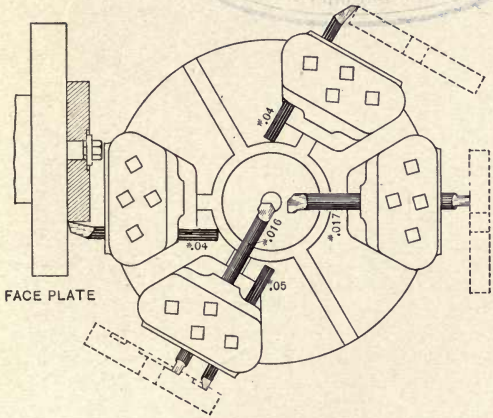


Finished in Two Operations—Second Operation

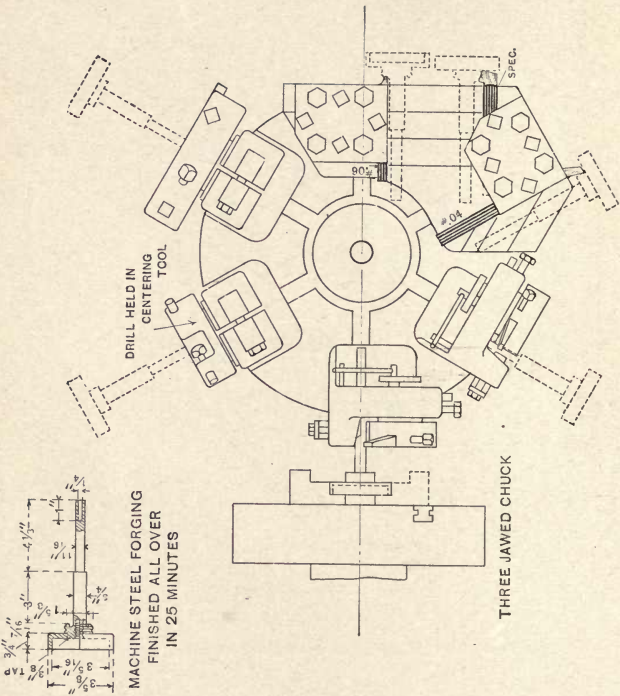


Finished in Two Operations—First Operation

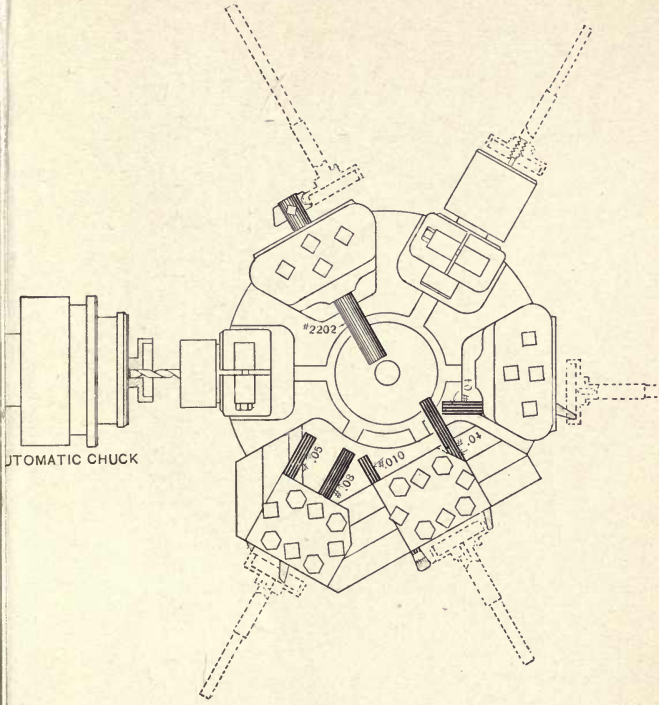
DOW PUMP & DIESEL ENGINE CO.
PROPERTY OF
SAN FRANCISCO WORKS



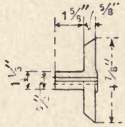
Finished in Two Operations—Second Operation

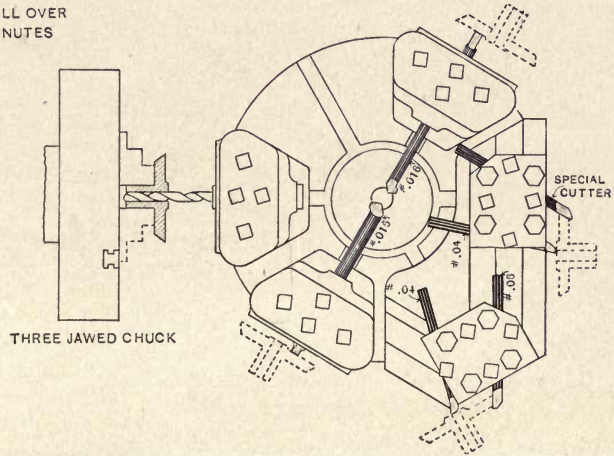


Finished in Two Operations—First Operation

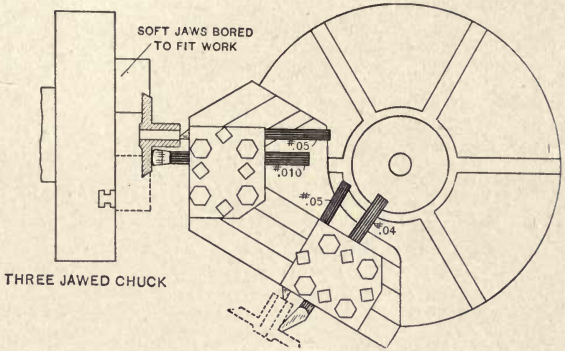


Finished in Two Operations—Second Operation

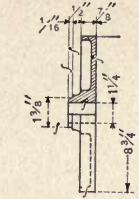




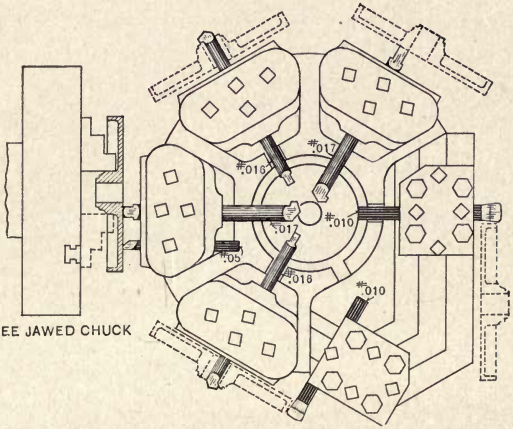
Finished in Two Operations—First Operation



Finished in Two Operations—Second Operation

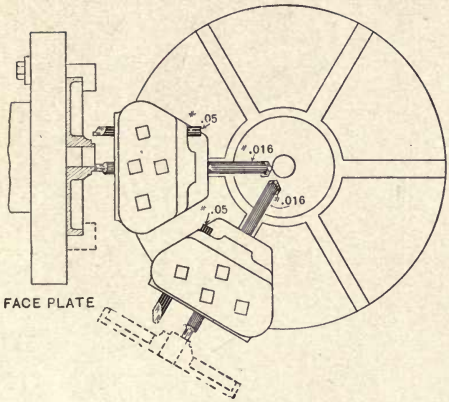


CAST IRON
FINISHED IN 15 MINUTES

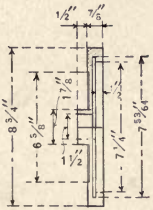


THREE JAWED CHUCK

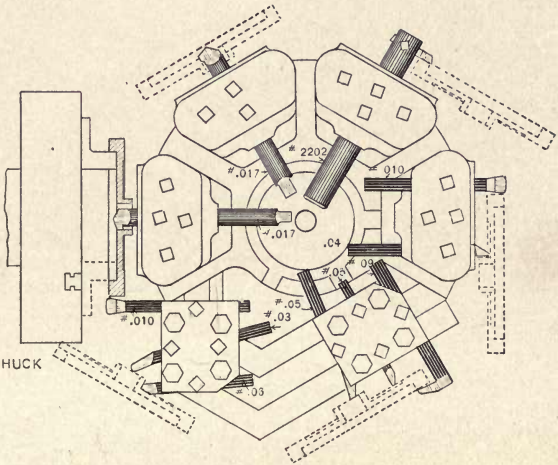
Finished in Two Operations—First Operation



Finished in Two Operations—Second Operation

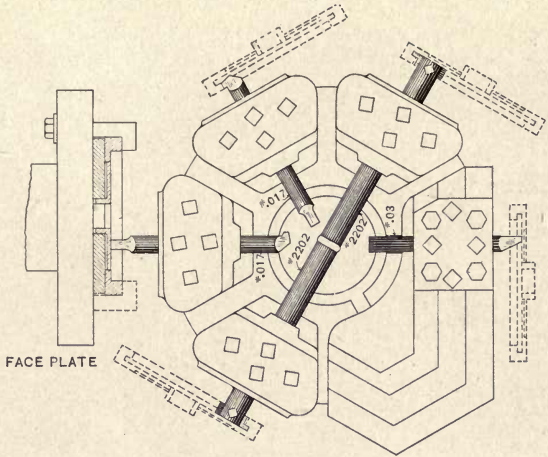


CAST IRON
FINISHED ALL OVER
IN 20 MINUTES

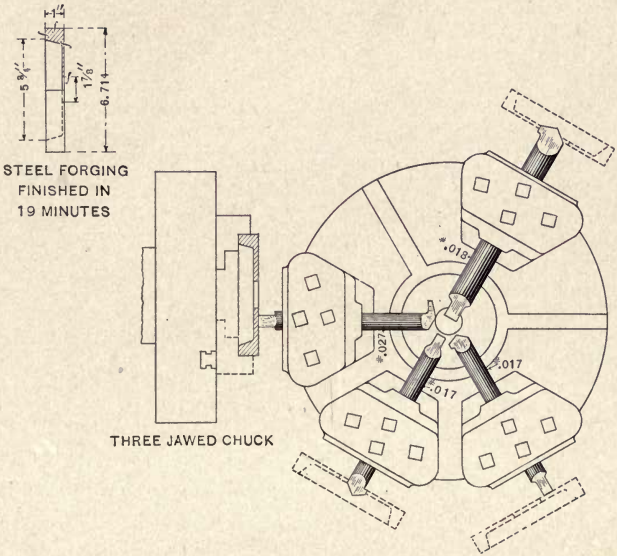


THREE JAWED CHUCK

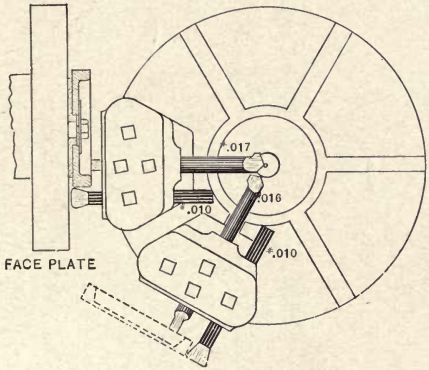
Finished in Two Operations—First Operation



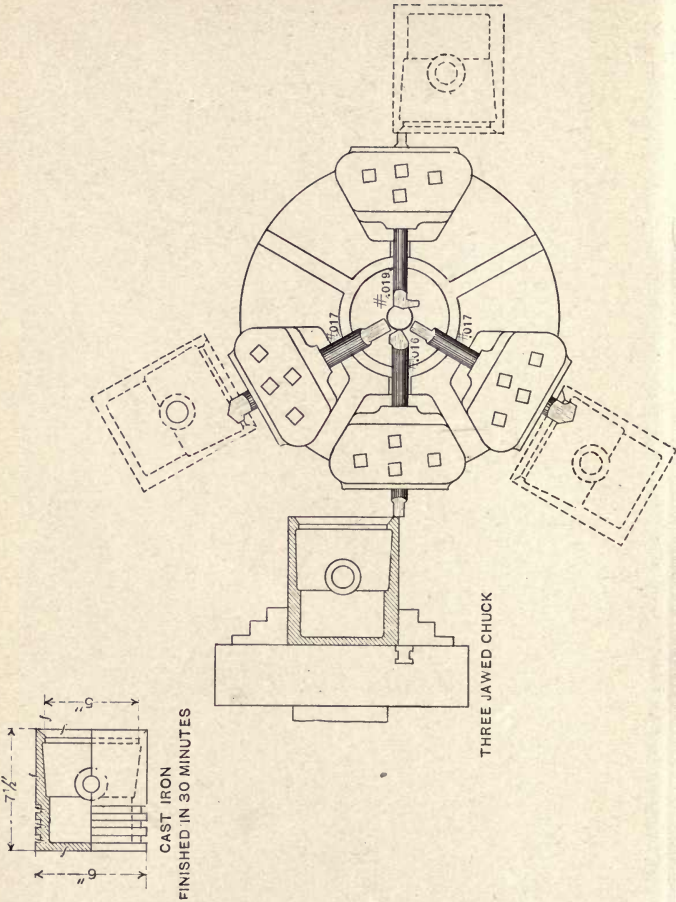
Finished in Two Operations—Second Operation



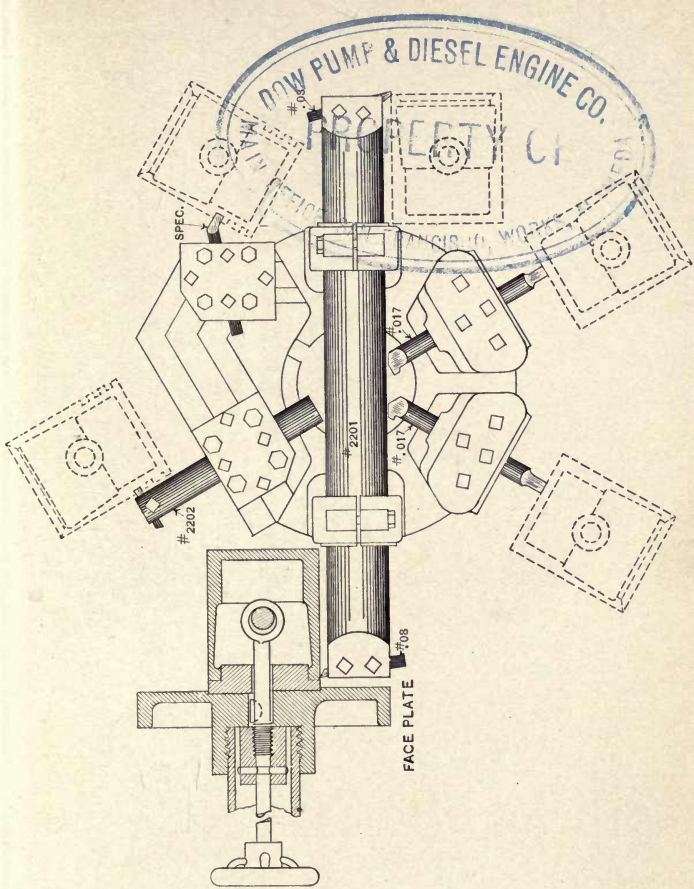
Finished in Two Operations—First Operation



Finished in Two Operations—Second Operation

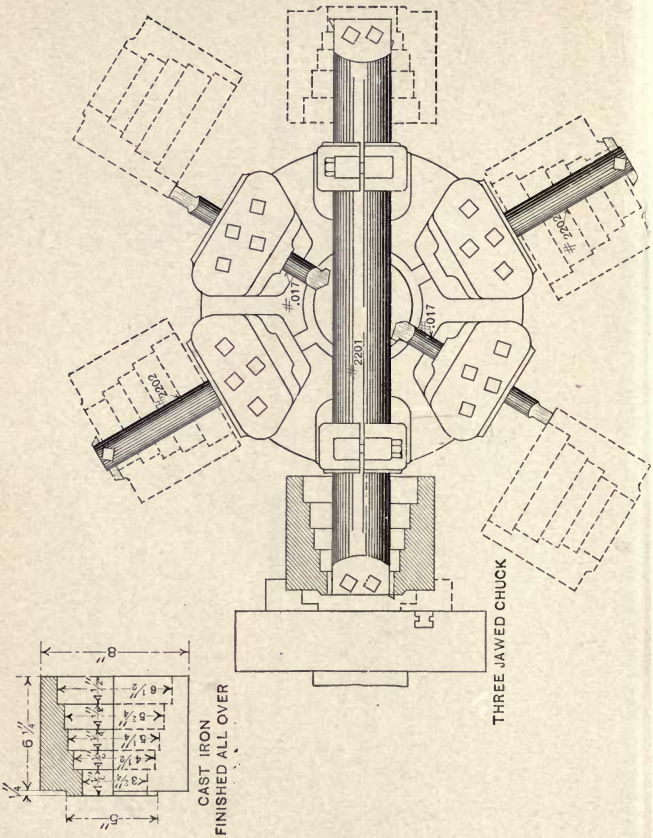


Finished in Two Operations—First Operation

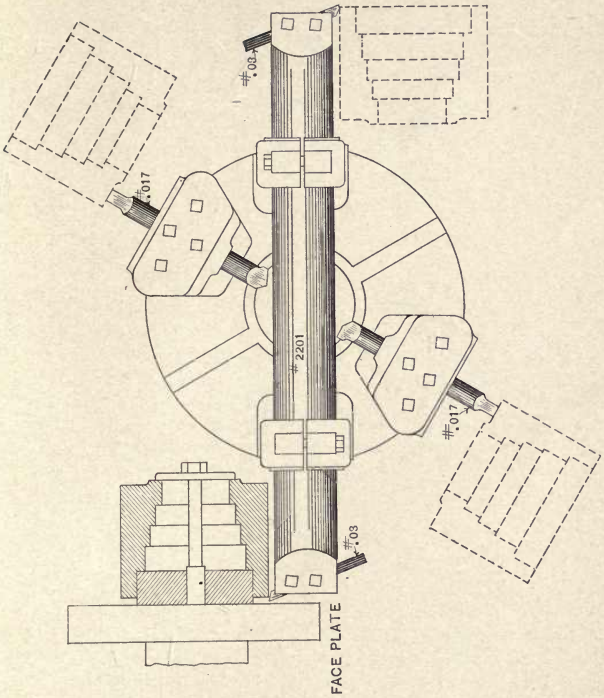


DOW PUMP & DIESEL ENGINE CO.
PROPERTY OF

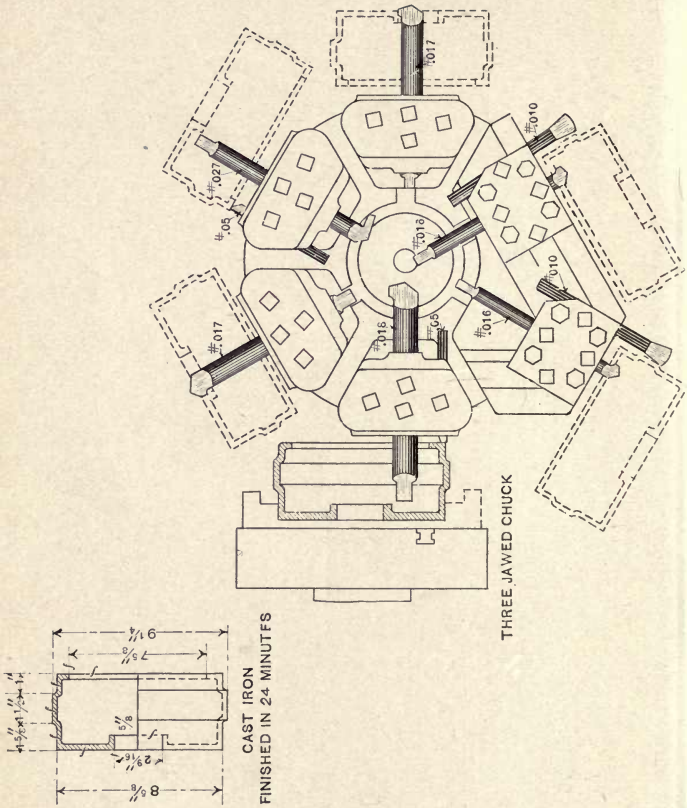
Finished in Two Operations—Second Operation



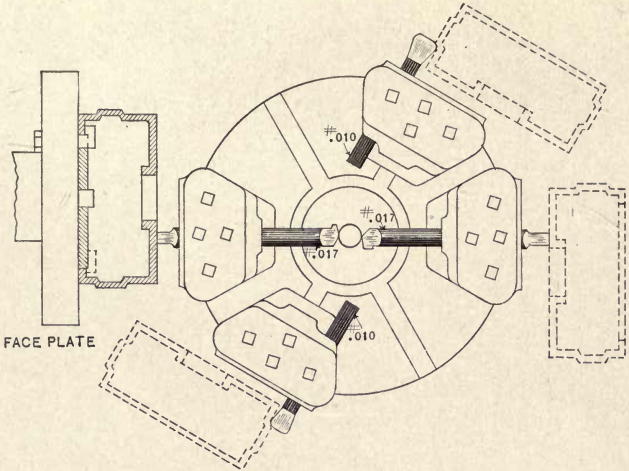
Finished in Two Operations—First Operation



Finished in Two Operations—Second Operation



Finished in Two Operations—First Operation



Finished in Two Operations—Second Operation

DETAILS OF OUTFIT OF TOOLS FOR BAR WORK UP TO 2¼-INCH BAR

The Machine One 2 x 24 Flat Turret Lathe, Cross-feed Head, Single Drive, four Tool Holders, three Stock Supports, Oil Pump and Piping, Friction Countershaft, Cast-iron Table for holding tools, etc., and suitable Wrenches.

Parts for handling the bar of stock Automatic Chuck and Roller Feed. Fifteen sets of Jaws for chuck, holding all sizes from ½ inch to 2¼ inches in diameter, inclusive.

Turning Tools Four Quick-opening Turners, adjustable to all sizes from 2¼ inches down.

One Cross Slide for holding cutting-off and forming tools.

One Pointing Tool.

Screw Thread Cutting One 1¼-inch Automatic (opening) Die, with fifteen sets of chasers for cutting all U. S. S. threads ⅜ of an inch to 1¼ inches in diameter, inclusive, by sixteenths.

All of the above may be briefly described as **2 x 24 Flat Turret Lathe, with the Automatic Die Outfit (Outfit D).**

DETAILS OF THE 2 X 24 FLAT TURRET LATHE WITH CHUCKING OUTFIT FOR WORK UP TO 12 INCHES DIAMETER

The Machine One 2 x 24 by 12-inch swing Flat Turret Lathe, Cross-feed Head, Single Drive, six Tool Blocks, four Tool Holders, Oil Pump and Piping, Friction Countershaft, Cast-iron Table for holding tools, etc., and suitable Wrenches.

Chucking Tools One 12-inch Face Plate.

One 12-inch three-jawed Scroll Chuck with reversible, three-step Jaws.

One extra set of Long-necked Jaws for inside gripping.

One extra set of Soft Blank Jaws that may be turned to fit any special form.

One dozen Outside Turning Cutters (one each 03, 06, 09; two each 04, 05, 07, and three 08).

Eight Inside Turning and Boring Cutters (one each 018, 019, 027, 028, and two each 016 and 017).

One 1½-inch Round Boring Bar, with two cutters.

One 2½-inch Square Extension Turning Bar, with two clamps.

All may be briefly described as **2 x 24 Flat Turret Lathe, with Chucking Outfit (Outfit C).**

DOUBLE OUTFIT FOR BAR AND CHUCK WORK

FOR BAR WORK UP TO 2¼ INCHES IN DIAMETER AND 24 INCHES IN LENGTH AND CHUCK WORK UP TO THE 12-INCH SWING CAPACITY

The Machine One 2 x 24 Flat Turret Lathe, Cross-feed Head, Single Drive, four Tool Holders, three Stock Supports, Oil Pump and Piping, Friction Countershaft, Cast-iron Table for holding tools, etc., and suitable Wrenches.

Parts for handling the bar of stock Automatic Chuck and Roller Feed. Fifteen sets of Jaws for chuck, holding all sizes from ½ inch to 2¼ inches in diameter, inclusive.

Turning Tools Four Quick-opening Turners, adjustable to all sizes from 2¼ inches down.

One Cross Slide for holding cutting-off and forming tools.

One Pointing Tool.

Screw Thread Cutting One 1¼-inch Automatic (opening) Die, with fifteen sets of chasers for cutting all U. S. S. threads ⅜ of an inch to 1¼ inches in diameter, inclusive, by sixteenths.

Chucking Six Tool Blocks.

One 12-inch Face Plate.

One 12-inch three-jawed Scroll Chuck with reversible, three-step Jaws.

One extra set of Long-necked Jaws for inside gripping.

One extra set of Soft Blank Jaws that may be turned to fit any special form.

One dozen Outside Turning Cutters (one each 03, 06, 09; two each 04, 05, 07, and three 08).

Eight Inside Turning and Boring Cutters (one each 018, 019, 027, 028, and two each 016 and 017).

One 1½-inch Round Boring Bar, with two cutters.

One 2½-inch Square Extension Turning Bar, with two clamps.

All the above may be briefly described as **2 x 24 Flat Turret Lathe, with Automatic Die and Chucking Outfits (Outfits D and C).**

DETAILS OF OUTFIT OF TOOLS FOR BAR WORK HANDLING FULL-LENGTH BARS UP TO 3 INCHES DIAMETER

TURNING ALL DIAMETERS UP TO 3 INCHES AND THREADING UP TO 2 INCHES DIAMETER

The Machine One 3 x 36 Flat Turret Lathe, Cross-feed Head, Single Drive, four Tool Holders, three Stock Supports, Oil Pump and Piping, Friction Countershaft, Cast-iron Table for holding tools, etc., and suitable Wrenches.

Parts for handling the bar of stock Automatic Chuck and Roller Feed. Seventeen sets of Jaws for chuck, holding all sizes from 1 inch to 3 inches in diameter, inclusive.

Turning Tools Four Quick-opening Turners, adjustable to all sizes from 3 inches down.

One Cross Slide for holding cutting-off and forming tools. One Pointing Tool.

Screw Thread Cutting One 2-inch Automatic (opening) Die, with nine sets of chasers for cutting all U. S. S. threads 1 inch to 2 inches in diameter, inclusive, by eighths.

All the above may be briefly described as 3 x 36 **Flat Turret Lathe, with the Automatic Die Outfit (Outfit D).**

DETAILS OF THE 3 X 36 FLAT TURRET LATHE WITH CHUCKING OUTFIT FOR WORK UP TO 14 INCHES DIAMETER

The Machine One 3 x 36 14-inch swing Flat Turret Lathe, Cross-feed Head, Single Drive, six Tool Blocks, four Tool Holders, Oil Pump and Piping, Friction Countershaft, Cast-iron Table for holding tools, etc., and suitable Wrenches.

Chucking Tools One 14-inch Face Plate.

One 14-inch three-jawed Scroll Chuck with reversible, three-step Jaws.

One extra set of Long-necked Jaws for inside gripping.

One extra set of Soft Blank Jaws that may be turned to fit any special form.

One dozen Outside Turning Cutters (one each 03, 06, 09; two each 04, 05, 07, and three 08).

Eight Inside Turning and Boring Cutters (one each 018, 019, 027, 028, and two each 016 and 017).

One 1½-inch Round Boring Bar, with two cutters.

One 3 x 3½-inch Extension Turning Bar, with two clamps.

All the above may be briefly described as **3 x 36 Flat Turret Lathe, with Chucking Outfit (Outfit C).**

DOUBLE OUTFIT FOR BAR WORK UP TO 3 INCHES DIAMETER AND 36 INCHES IN LENGTH, AND CHUCK WORK UP TO 14-INCH SWING CAPACITY

The Machine One 3 x 36 Flat Turret Lathe, Cross-feed Head, Single Drive, four Tool Holders, three Stock Supports, Oil Pump and Piping, Friction Countershaft, Cast-iron Table for holding tools, etc., and suitable Wrenches.

Parts for handling the bar of stock Automatic Chuck and Roller Feed. Seventeen sets of Jaws for chuck, holding all sizes from 1 inch to 3 inches in diameter, inclusive.

Turning Tools Four Quick-opening Turners, adjustable to all sizes from 3 inches down.

One Cross Slide for holding cutting-off and forming tools.

One Pointing Tool.

Screw Thread Cutting One 2-inch Automatic (opening) Die, with nine sets of chasers for cutting all U. S. S. threads 1 inch to 2 inches in diameter, inclusive, by eighths.

Chucking Six Tool Blocks.

One 14-inch Face Plate.

One 14-inch three-jawed Scroll Chuck with reversible, three-step Jaws.

One extra set of Long-necked Jaws for inside gripping.

One extra set of Soft Blank Jaws that may be turned to fit any special form.

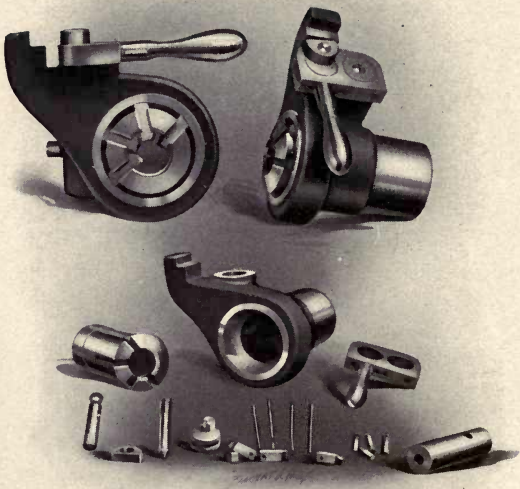
One dozen Outside Turning Cutters (one each 03, 06, 09; two each 04, 05, 07, and three 08).

Eight Inside Turning and Boring Cutters (one each 018, 019, 027, 028, and two each 016 and 017).

One 1½-inch Round Boring Bar, with two cutters.

One 3 x 3½-inch Extension Turning Bar, with two clamps.

All the above may be briefly described as **3 x 36 Flat Turret Lathe, with Automatic Die and Chucking Outfits (Outfits D and C).**

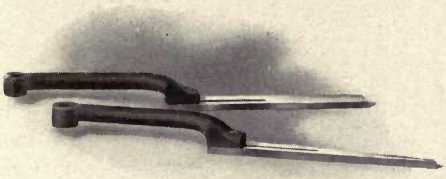


Taper Turner

TAPER TURNER

ON the preceding page we illustrate our taper turning tool, which may use a single cutter and three back rests, or six cutters. It is provided with convenient means for varying the degree of taper and size without change of template.

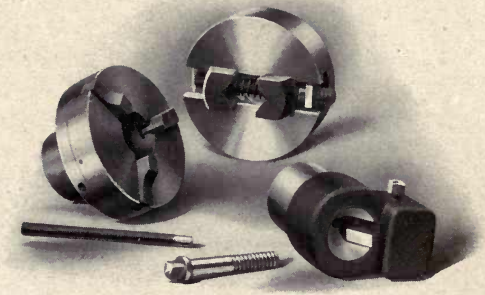
This cam in turn is controlled by a wedge-shaped former or template shown below.



Formers for Controlling the Taper Turner

The simplicity of this tool will appeal to all having had experience with previous types of taper turners.

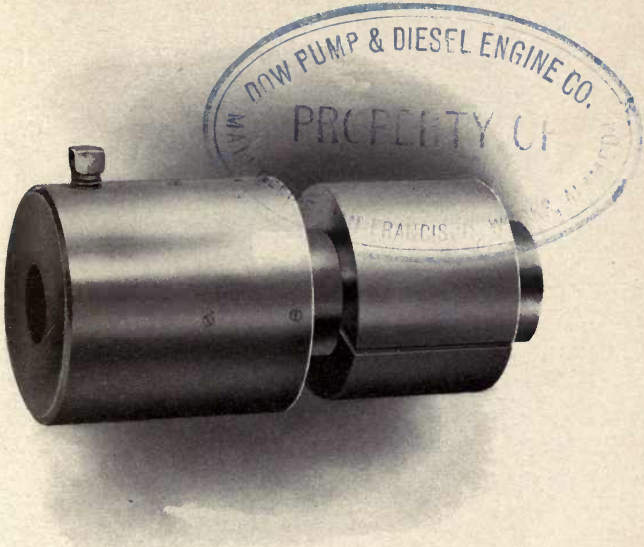
In the illustration the upper former is blank and may be planed to any taper. The lower is ready for use.



Three-jawed Centering Chuck, with Shank to fit Turret Tool Holder. Two-jawed Chuck Fitted to Spindle Bell-mouth Pointing Tool

THESE two chucks are used for locomotive frame bolts and other forgings in which there is a scant amount of stock for turning and with a head which may be forged on a trifle eccentric. The three-jawed chuck centers the forging by its body while the two-jawed chuck is constructed to grip the bolt-head where it finds it regardless of its eccentricity.

The pointing tool is used on the same work but may also be used on any work requiring beveled point.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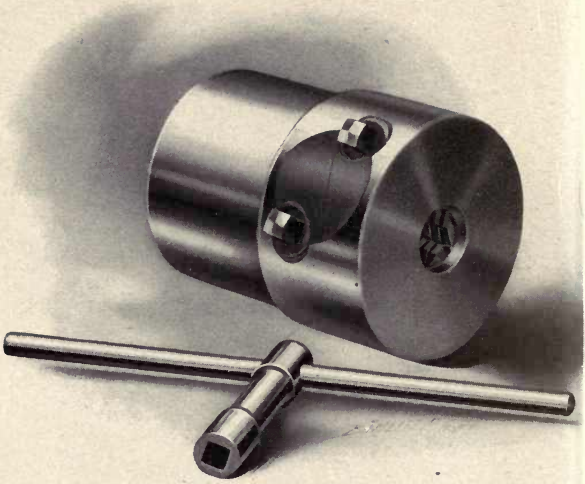
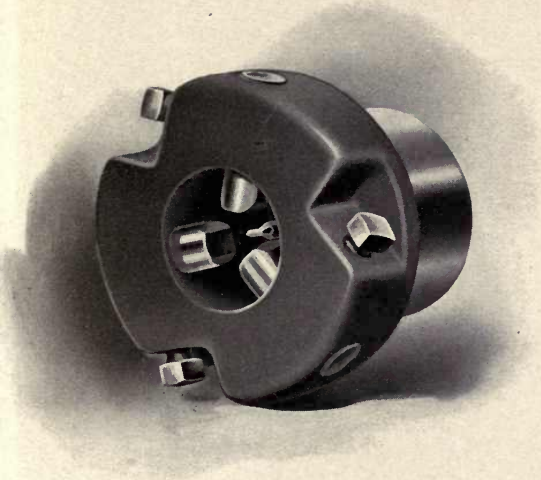
Clutch Tap Holder

THE clutch tap holder resists the cutting strain until the tap has reached the desired depth, at which point the carriage is stopped, causing the clutches to pull apart and allowing the tap to rotate with the work until spindle is reversed for screwing it out.



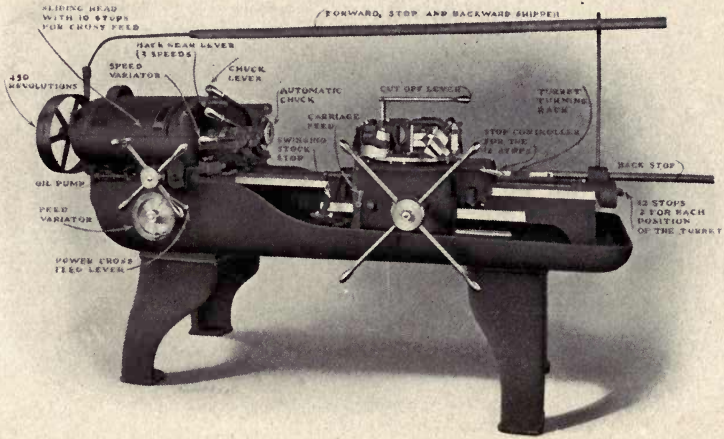
Chuck for Holding Drills

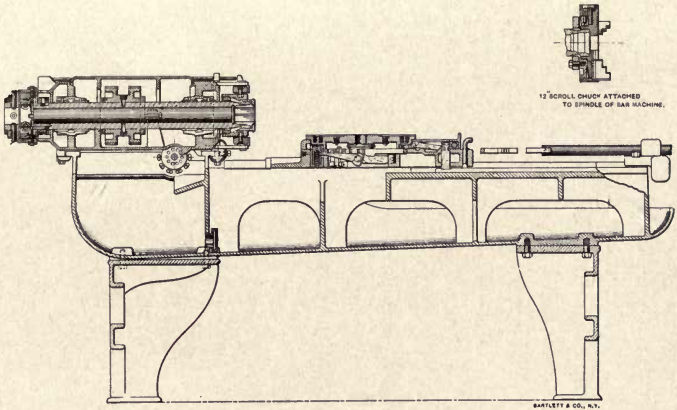
CHUCK for holding drills. The chuck body is held in one of the turret tool holders.



Centering Tool

CENTERING tool is for drilling centers in work for grinding or other purposes. By careful adjustment of two of the back rests just a little nearer the center than the third rest, absolutely true centering can be done.

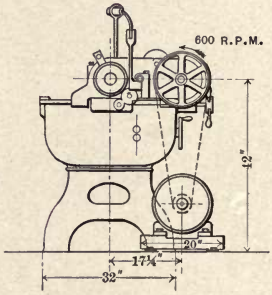

SLIDING HEAD WITH 10 STOPS FOR CHUCK FEED
FORWARD, STOP AND BACKWARD SHIPPER
HACK SAW LEVER (3 SPEEDS)
SPEED VARIATOR
CHUCK LEVER
450 REVOLUTIONS
AUTOMATIC CHUCK
CUT OFF LEVER
TURRET TURNING RACK
CARRIAGE FEED
SWINGING STOCK STOP
STOP CONTROLLER FOR THE 12 STOPS
BACK STOP
OIL PUMP
FEED VARIATOR
12 STOPS 2 FOR EACH POSITION OF THE TURRET
POWER CROSS FEED LEVER



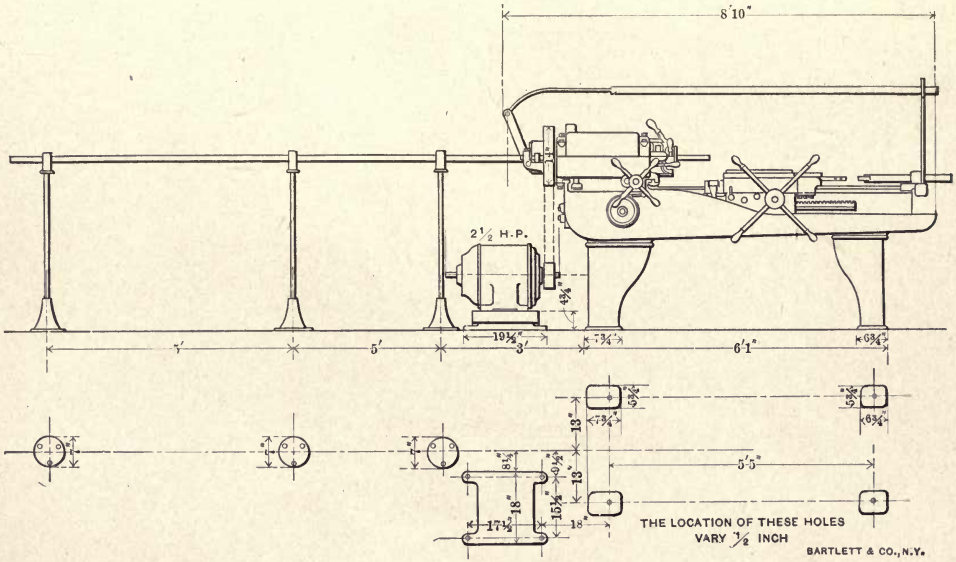
2 x 24-inch Turret Lathe, with Cross-feed Head
Vertical Section

ELECTRIC drive is shown on this and the opposite page.

The motor is mounted on a base that compensates for the change in center distance as the sliding head travels. The starting box may be attached to the face of the machine or to the iron work table which accompanies each machine having the chucking or bar outfit. Any constant speed motor may be used. No variation in speed is required in the motor, neither is it necessary to reverse the motor, for all such changes are obtained by mechanism in the head.

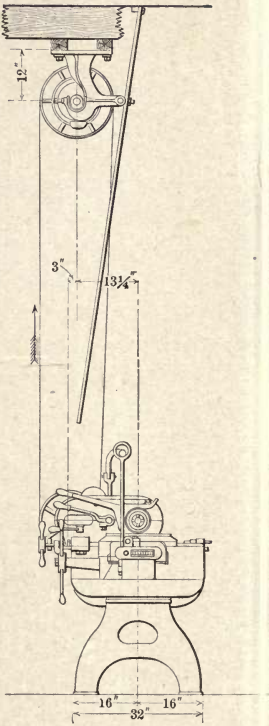


End Elevation Electric Drive for 2 x 24

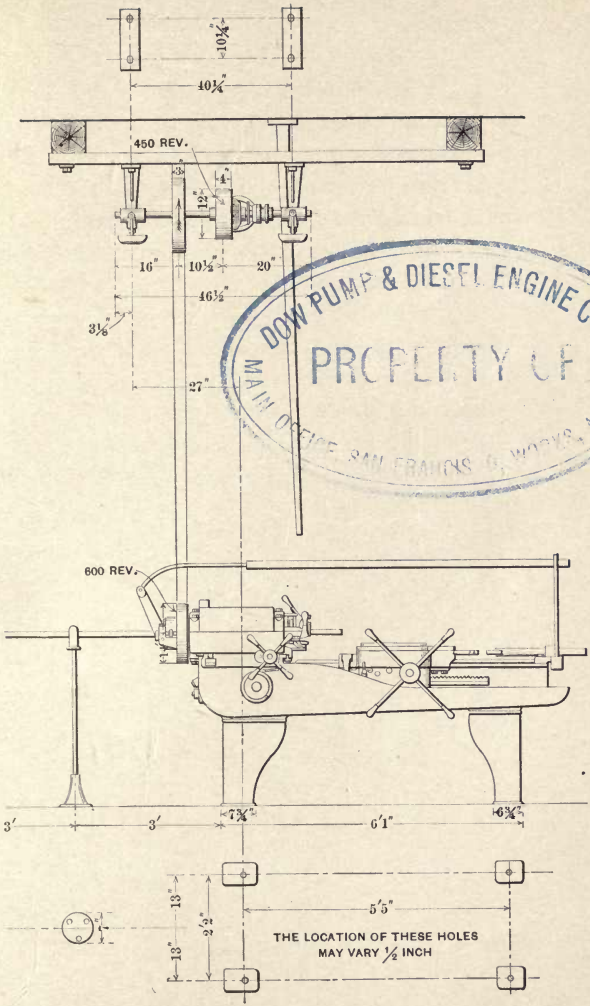


Front Elevation Electric Drive for 2 x 24

Only one stock support is shown on opposite page on account of smallness of page. Three supports are furnished. The second is placed 3 feet from the one shown in cut and the third is placed 5 feet beyond the second support.



Countershaft Drive, End Elevation of 2 x 24



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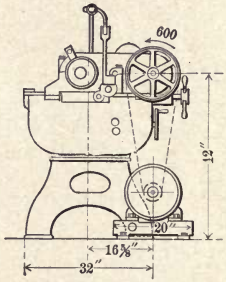
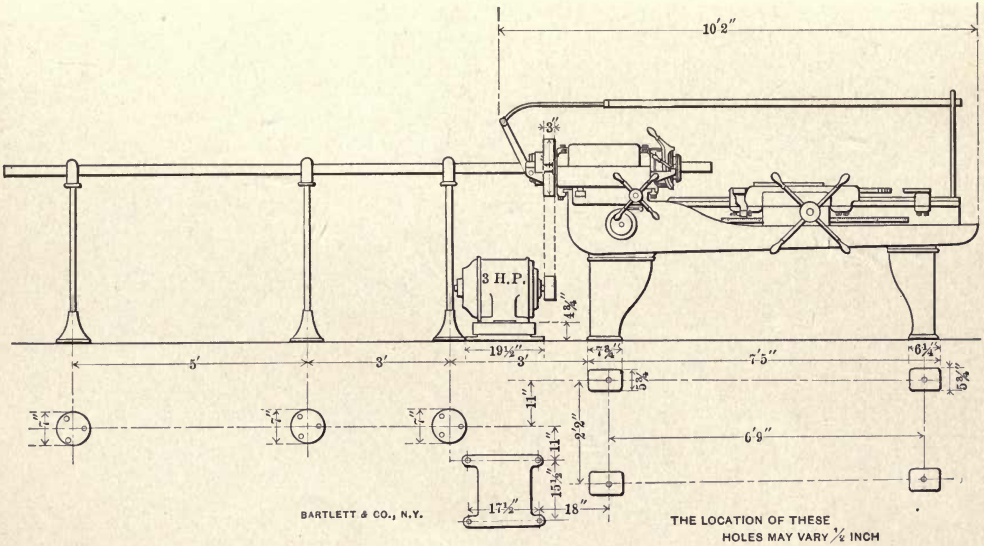
Plan for Setting up 3 x 24 Flat Turret Lathe withtCountershaft

ELECTRIC drive is shown on this and the opposite page.

The motor is mounted on a base that compensates for the change in center distance as the sliding head travels. The starting box may be attached to the face of the machine or to the iron work table which accompanies each machine having the chucking or bar outfit. Any constant speed motor may be used. No variation in speed is required in the motor, neither is it necessary to reverse the motor, for all such changes are obtained by mechanism in the head.

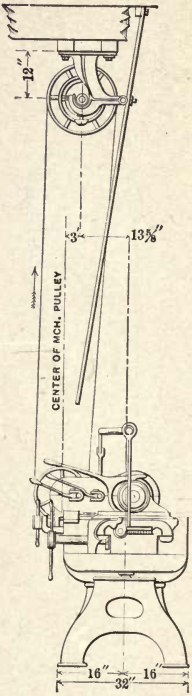


End Elevation Electric Drive of 3 x 36

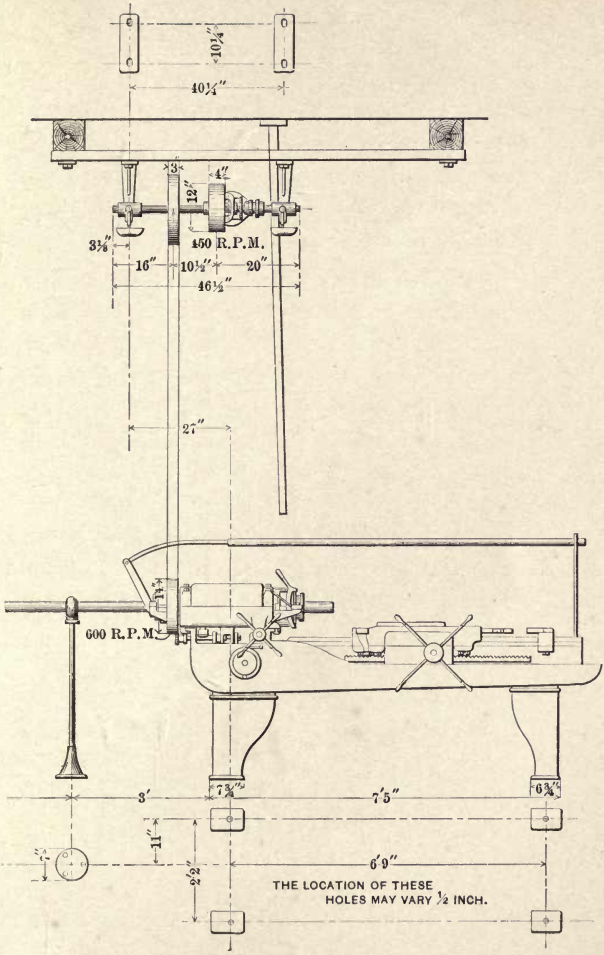


Front Elevation Electric Drive for 3 x 36

Only one stock support is shown on opposite page on account of smallness of page. Three supports are furnished. The second is placed 3 feet from the one shown in cut and the third is placed 5 feet beyond the second support.



End View of 3 x 36



Front Elevation of 3 x 36 with Countershaft

DIRECTIONS FOR "SETTING UP" AND OPERATING

BOLT the machine to the floor before putting on the belt. Do not adjust the position of the machine to the running of the belt. Set the machine true with the countershaft or main line by dropping down a plumb bob from each end of the shaft. Since plumb bobs are not in the kit of every machinist, an inch nut or any weight on the end of a string thrown over the shaft will answer. The countershaft should line up perfectly with the shaft from which the power is received and it should be perfectly level. It should be well oiled before starting and examined after it has run fifteen minutes to see if any of the bearings are warm.

After the machine has been set parallel with the counter, the lag screws should be put through the legs into the floor, but should not be screwed down until after the machine is leveled. As the bed rests on three points and is flexibly connected to one

pair of legs, the leveling of the machine is not done in the usual way. When the level is placed across the V's of the lathe bed and is found to be a little high on one side, drive the wedges under the edge of the leg at head end. Do not try to change it by wedging up under the back leg, for it is not connected to the bed by the usual means, but only serves as a pivotal support. Wedging under this leg will only raise or lower this end of the machine. Care should, however, be taken to have this leg stand on a fairly level spot. Now place the level on one of the V's lengthwise and wedge up carefully until both ends of the machine are equal in height.

Locate the stock supports as indicated in the drawings and adjust them for height by placing a bar of stock in the machine and slowing revolving it.

If the countershaft clutches slip, screw up the two small nuts at the rim of friction and slightly turn each the same amount. The speed should be exactly 450 revolutions

per minute. If this speed is not as prescribed, the table of sizes of work for which the various speeds are intended will be of no value. This table is furnished for ready reference in a suitable frame with each machine.

Do not put your belts on too tight at first. It is much easier to lace the belt two or three times while it is stretching than it is to get a new bearing running smoothly after it has been roughened up by the belts being too tight.

All new bearings should be frequently oiled and run with care.

To Start the Machine on Bar Work, begin on some very simple work. Suppose the diameter of the head is $1\frac{13}{16}$ and the body $1\frac{1}{4}$ inches, that the total length is 6 inches and that the piece must be finished all over. Get a bar of $1\frac{7}{8}$-inch stock; see that it is fairly straight and free from short kinks and that there is no burr of any size on either end. If the bar has

been cut off in the shear, the burr should be hammered down. The large adjusting collar under the sleeve should be screwed back to open the chuck and forward to close it. Now remove the bushing from the spindle, for this is only used for smaller bars than 1 inch, and would not admit the 1 7/8-inch bar. It is necessary to let back the rolls in the roller feed in order to remove this bushing. After this is done, push the bar through the stock supports into the spindle and through the chuck until the end projects about 3/4 of an inch beyond the face of the chuck. Adjust the jaws at the back of the roller feed till they are about 1/32 of an inch loose on the stock. Adjust the chuck till it requires much force to thrust the chuck lever to the left. The rolls of the roller feed should be set down against the bar till each spring is raised a trifle.

Now, the next thing is to determine the speed to be run. This can be done by the use of the table, or by experience. Turn

the turret around until the cross slide comes in working position, set the cut-off tool and trim off the rough end of the bar. Before turning to the next place, set the stop. See directions for adjusting the stops on page 222. No. 1 is the stop for the cross slide. Next move the "back stop" up close and clamp it. Run the turret back against it till it turns to the next position; next loosen the back stop again and push it back till the end of the swinging "stock stop" measures a distance equal to the length of the work, which is 6 inches, plus the width of the cut-off tool, which we will call $\frac{3}{16}$. That is, the stock stop should be swung up into place, and the turret should push the back stop until the length between the end of the bar in the chuck and the end of the stock stop is equal to $6\frac{3}{16}$ inches; then clamp the back stop firmly.

Now open the chuck and hold the lever to the right until the roller feed pushes the bar out against the stop, then forcibly close the chuck. Turn the turret to turner. Now

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use the turner carefully and without the back rest, till the cutter is adjusted to size. This must be done on the first piece by use of calipers or any other gauge; take off about ⅛-inch chip each time while roughing, and allow it to run on about ¾ of an inch. After the end has been reduced to 1¼, adjust the back rest, have it follow the tool and bear on the 1¼ size, then throw in the feed by the lever on front of the apron near the pilot wheel. Let this cut run up the required distance and adjust the feed stop for this tool.

Before running back, withdraw the tool by pulling the small cam lever towards you. Run back the turret until it brings the next tool into position, and adjust this tool for turning the head of the piece; the head may be turned without the use of the back rest.

Now the end of the piece may be shaped by the pointing tool held in one of the tool holders. The screw cutting comes next. Directions for using the automatic die will

be found on pages 234 to 239. The next operation is rounding the head, which may be done by an offset tool in the back tool post of cross slide, or it may be done by putting a crowning tool in place of the cut-off tool and then having the cut-off tool work from the back post of cross slide. By using the former instead of the latter, an additional tool may be set in the back post for shaving the under side of the head. This, however, is not often necessary. Then cut the piece from the bar and proceed to run off the required number.

If but one piece is desired, it is not necessary to set any of the stops. These stops were set only for the benefit of more rapid production of the other pieces wanted. In starting the turner on a piece of this proportion, do not throw in the feed until the edge of the back rest is started on the work; it should be fed thus far by hand. The fine feed should be used with a chip of this kind, but if the tool is beveled slightly, the medium feed can be used.

If the Bar is crooked and the end runs out too much to true up, the piece may be partly severed from the bar, enough to weaken it so that it can be bent to run true.

The Jaws may be used on work a trifle larger, but never on smaller diameters than is marked on the jaws. For instance, the $1\frac{7}{8}$-inch jaws will hold $1\frac{15}{16}$, but will not hold $1\frac{13}{16}$. The latter size must be held by the $1\frac{3}{4}$-inch jaws.

Hexagon Stock is held by the same jaws that hold round and square by removing one of the jaws and inserting spacers that will hold the jaws in place for taking bearing on three sides of the stock. Round stock may be held in the jaws as arranged for holding hexagon or square, but if it is a trifle oval in section arrangement of jaws for hexagon is better.

The Chuck should be wiped clean every time the jaws are changed, and should be kept well oiled. To remove the chuck

from the spindle of the 3-inch machine it should be gripped on a short piece of 2-inch stock to which a lathe dog is fastened. By the use of a lever placed between the tail of the dog and the bar of stock, the chuck may be readily loosened. This also serves as a good means of screwing the chuck firmly against the collar when putting it on again.

The chuck body of the 2-inch machine is part of the spindle and cannot be removed.

The Roller Feed should be kept as clean as possible and well oiled. The bar of stock should be wiped free from grit and dirt before the bar is placed in the machine.

The Turret Stops and how to adjust them. There are 12 feed stops for the turret, two for each position of the turret. These stops are numbered A1 and B1 for No. 1 turret position, and A2 and B2 for No. 2 turret position, and so on up to 6. The lever marked stop controller is arranged to lift out of position all of the A

stops or all of the B stops, or both the A and B stops. When only one stop is required for each position of the turret, the stop controller is set to keep either the A or the B stops out of position, allowing the others to do the work.

If more than two stops are required for any one position, then the extra stop pin at the back of the turret slide may be dropped into any one of the other five holes, thus borrowing one or more of the B stops not required by the other tools. This extra stop scheme makes it possible to give one of the tools seven stops, if desired, and still leave one stop for each of the other five tools.

Each of the 12 stop bars is held in place while setting by the set screw directly over it, but these set screws should not be set down hard or depended upon for holding against the carriage feed. The stop binder at the side clamps all of the stops together and should be set hard.

The notched edge of the stops should be up when the stop is to arrest the forward

motion of the carriage, and down when stop is to arrest motion of carriage traveling away from the chuck.

The back stop serves two purposes: first, it forms an abutment for the rack that turns the turret; and second, it determines the backward travel of the turret, and thus locates the stock stop which is attached to the turret carriage. The back stop should be set with reference to the desired position of the stock stop, against which the bar of work strikes when a new length of work is being pushed out of the chuck. Care in setting the back stop will leave very little to be done in adjusting the screw at the end of the stock stop.

The Turners. The adjustments for the turning tools and for the back rests are provided with binder screws to prevent their moving after being once set. These screws are set up with a screw driver from the back of the turner. The cutters may be made of self-hardening, or ordinary tool steel.

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For all kinds of work, set the tool so that the part of it that does the finishing is just a trifle ahead of the back rest. The tool should be so adjusted that the part that does the finishing will come exactly to the center of the bar when the tool holder is swung in.

The double adjustment of the turner is effected by the employment of a double-throw cam, instead of the single cam formerly used, and a double-end latch back of the back rest.

The two cams are diametrically opposite and side by side. The lever for turning the cams is like a machinist's vise handle. When one end is up, one of the cams engages one of the adjusting screws, and when the other end of the handle is up, the other cam is brought against the other adjusting screw.

The Cutting Tool used in the Turner is usually ground so as to leave a square shoulder. This form of tool, with plenty

of rake, is preferable for several reasons, although it is not the form of tool that has been found to take the largest cuts under other conditions. It is not recommended for chucking operations or turning without the back rests.

Since the use of high-speed cutters the limit of turning speed has been determined by the endurance of the back rests, and since the pressure on the back rests is increased by the use of cutters having beveled or rounded corners, this is one of the reasons for using the cutter which leaves a square shoulder.

Of course it is assumed that the rake or top angle of the tool is always to be as sharp as experience with this machine would determine.

Another reason for the tool that takes this square or face cut is that it leaves the kind of a shoulder that is usually required.

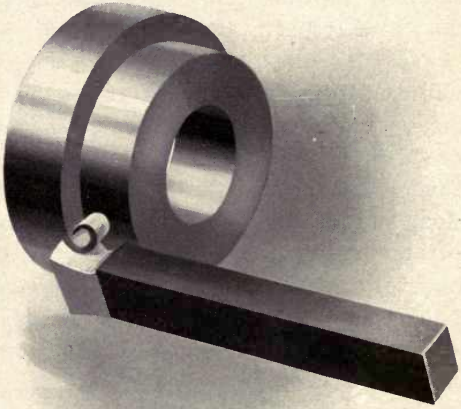
Still another reason for its use is that the cutting pressure to hold it into its chip is mostly end pressure on the work and not

radial—that is, no very great pressure is required to hold it into the proper depth to produce the desired diameter, hence a slight variation in depth of chip due to eccentricity of stock has little or no tendency to change the position of the tool. For this reason this tool may be depended upon for true work in taking long cuts, even if the stock runs a trifle crooked.

The Cutting Tools for Chucking operations, whether turning or boring, should have their rake or top angle sharp to the heaviest part of the chip. For instance, if a tool is to be used for facing a hub of a gear, the part that begins to cut first should be a sharp angle, so that the heaviest part of the chip should flow easily away, while that part of the tool that leaves its mark on the finished face should take a shearing cut or angular shaping cut, which leaves the smooth surface.

Perhaps there is no more important point to be borne in mind by any one wishing to

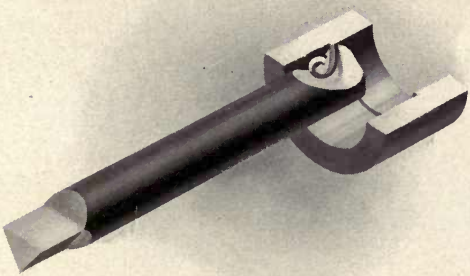
know how to make the machine do its best work than the cutting angles of the tools. In a general way every one knows that a tool should have the least amount of clearance and the greatest amount of rake consistent with the wear of the tool, but



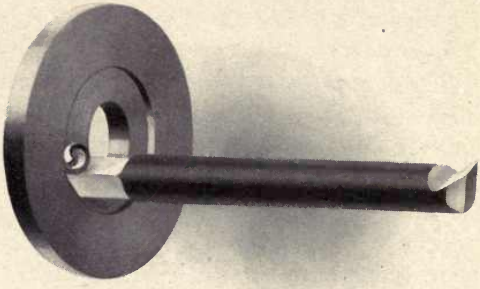
Turning Tool

the man who makes the greatest record is the one who puts it into practice.

The next point is that no tool should be allowed to project beyond its holder or support more than is absolutely necessary. After having ground and set the tool properly, see that it has a chip or feed coarse enough to keep it from losing its edge in the vain employment of making thin chips—for if the chips are very fine it means that you have made the tool not only remove the



Boring Tool



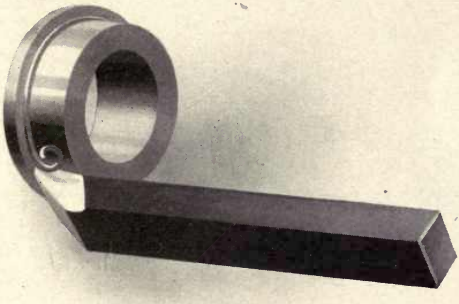
Facing Tool

metal, but cut it into fine chips having no special value. Even weak lathes generally do better work with a medium feed than a fine feed. It is not uncommon to see a very fine feed being used in trying to turn an extra true piece of work, with the only result that the tool does not leave an even surface. It alternately rides and "digs in" with a fine feed, when an even, steady cut would have been obtained by a medium feed.

Chattering frequently occurs because there is not chip or cut large enough to hold all

the slack of springing parts. The cure for chattering is frequently more, not less, feed. Of course chattering may be caused by a cut that is just heavy enough to balance the weight of the work and spindle, and then the slight necessary looseness of spindle bearings gives the chance for chattering. An old-fashioned remedy for this is to turn the tool upside down to get the pressure down on the work.

Chattering is destructive of the sharp edge of the tool and should be stopped as

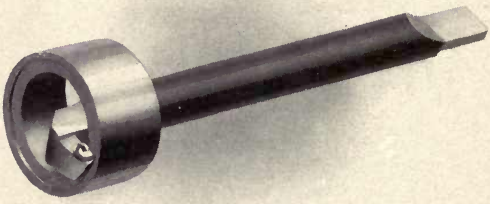


Cornering Tool

soon as noticed; but don't think a lighter cut is necessary, for frequently a heavier cut stops the chattering.

Facing cuts should be taken by the tools with round shanks, for these can be turned so as to give the desired rake for free cutting.

In facing a piece in which the diameter of the cut in one place is two or three times its smallest diameter, make sure to take advantage of the convenient means of changing the speed, for a very important reduction



Back-facing Tool

in time of operation as well as the durability of the tool may be effected by using the speed controller.

The Cross Slide is arranged with stops for the front and back tools. The upright which supports the pinion shaft is bored out to receive bushings for supporting the work against the forming tool when it is necessary to use a broad tool near the end of a slender piece of work.

Never use a longer drill than is absolutely necessary. If the depth of the hole is to be great in proportion to its diameter, a short, stiff starting drill should be used to start a true hole. Never drill beyond the piece that is to be cut off, for after the piece has been cut off and the bar run out to make another, it will be found that the end does not run exactly as it did when it was drilled into, and consequently the hole runs out. In some cases, where the mouth of the hole is to be larger, it does not make any difference, because the larger

drill will true the hole, but generally it makes trouble that is difficult to overcome without the waste of stock.

The stock-stop screw must be lengthened out when drills are used, and the length of the extension should be equal to the length of the longest drill used.

Putting Chasers into the Die. One set of chasers may be removed and another put into place by simply withdrawing the two knurled thumb screws which are located in approximately opposite positions on the cam holder. After these screws have been withdrawn about one-quarter of an inch the cam holder may be removed. In changing the chasers always see that the chaser grooves in the die are wiped out clean; also that the interior of the cam holder and cam are free from chips and dirt. Place the chasers in the respective grooves in the die body by making the numbers on the chasers correspond to those on the body; then slide them towards the

center till they meet. Now put on the cam holder, and after having pushed it as far back as possible with the chasers in this position, push each of the chasers out against the cam surface; this will allow the cam holder to go back the full extent. Now see that the screws in the cam holder enter the holes in the spring collar.

To Close and Adjust Size. To close the die pull the handle with the thumb pressing gently on the latch pin. Before adjusting the die for size see that the latch pin is in its notch, and that the O. K. is uppermost; then turn the adjusting screw till the lines on the cam and chaser come together. This gives only an approximate adjustment; the micrometer or thread gauge should be tried on the work. A binder screw will be found to prevent accidental turning of the adjusting screw.

Adjusting Cutting Length. Now the die is ready to cut its thread, but it is yet

necessary to adjust the stop which will determine the length of the thread. The stop which arrests the motion of the carriage is the one which determines the length of the thread, for when the die is cutting it is only necessary to retard the travel of its holder to cause it to fly open. If the thread is to be cut close to the shoulder the stop must be so adjusted as to avoid all possibility of the chasers screwing against the shoulder. It is not safe to allow the chasers to get closer to the shoulder than $\frac{1}{32}$ of an inch. The die head travels forward $\frac{3}{16}$ of an inch before opening after the carriage has been arrested.

Roughing and Finishing Cuts. One cut is sufficient for all U. S. S. threads under 1 inch in diameter, under ordinary conditions, but to obtain best results on larger dimensions, extra coarse pitch or very rough material, two cuts are necessary. The latch pin is made reversible for this purpose. It may be readily turned from one position to the other after it has been

pulled out. The letters O. K. should be uppermost when the finishing cut is taken. The work should never be allowed to run backwards in the die.

Cutting Speeds for Screw Cutting. Do not run your work too fast. If the pitch is extra coarse or the work warm from previous operations, the speed of threading should be proportionately slower. Better half speed than a trifle too fast. Do not turn the part to be threaded under size, for the line of travel of the die is governed at the top of the thread, without which the die is inclined to travel crooked or to *wabble.*

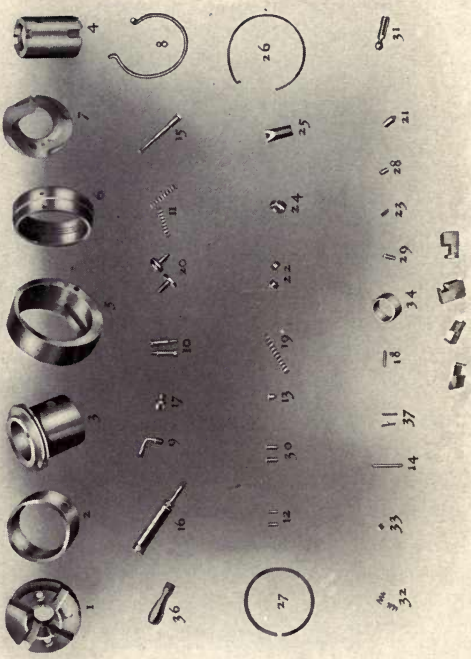
Use Lard Oil Only. Always use a heavy stream, from at least a ¼-inch pipe, of lard oil in cutting tenacious irons and steels. The so-called cutting oils and compounds of soda and oil give good results on brittle material only. Nothing less than lard oil *that is lard oil* should be used in cutting the general run of Bessemer and open-

hearth steels, as well as tenacious irons, as they are found on the market, for these metals will average tough and hard. If the same purse pays for the labor and tools that pays for the oil, there is no saving in buying a cheap oil, whether it is called lard oil or some more truthful name.

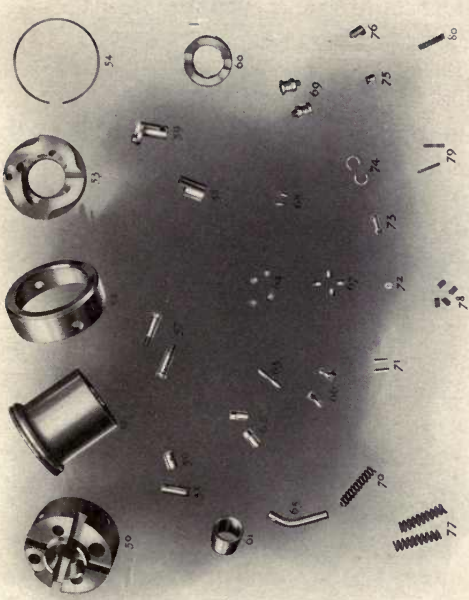
To Resharpen the dies grinding must be done very sparingly. Grind the least possible amount off the face; do the principal grinding in the throat of the die. This, of course, carries back the cutting edge into the die so far that it is impossible to cut close to a large shoulder. If the work requires cutting close to a small shoulder, the chasers may be ground back enough to admit that shoulder. Some grinding must be done on the face of the die, as it wears back to the last threads, but it should be done with great care. In grinding the throat, do not follow the curved lines of the teeth in order to obtain the correct clearance, for the teeth were produced by a mill 2½

inches in diameter; following this shape would give too much clearance. Don't change the angle of chamfer; it is better to be guided by the wearing of the die. See that each chaser is ground an equal amount, either by gauge or by bringing the teeth only to a cutting edge.

Ordering Parts. The chaser and all other parts of the dies are made by special machinery and are perfectly interchangeable; any one of the standard chasers may be duplicated from stock, and special chasers on short notice, providing you give in your order all the letters and numbers appearing on the chaser. Chasers may be sent by mail. When ordering other repair parts please use list number of piece given on pages 240 and 241, and always state size of die head. The head which has capacity for threads up to 2 inches diameter is called No. 6, the 1¼-inch capacity No. 3 (cut on page 241 illustrates parts of our later pattern 1¼-inch die, No. 4), and the ½-inch capacity No. 1.



Parts of Nos. 3 and 6 Dies



Parts of No. 4 Die

TRAVELING DIRECTIONS FOR VISITORS

Our entire plant is open to those interested enough to come to see us.

Springfield, Vermont, the home of the Flat Turret Lathe, is located near the Connecticut River just north of Bellows Falls.

It is reached by a modern freight and passenger electric railway which connects with the Connecticut River Division of the Boston & Maine Railroad at Charlestown, New Hampshire.

The electric railway cars meet all trains, including the midnight, and take the travelers directly to the office and works of the Jones & Lamson Machine Company, which is located on the electric line, three minutes' walk from the terminus.

The Adnabrown Hotel, at the end of the railway, is of course ready to receive guests at any hour.

Travelers from Boston come via the Fitchburg Division of Boston & Maine Railroad

through to Bellows Falls, at which junction they change cars to the Connecticut River Division for an eight-mile ride north to Charlestown, where an electric car will be found awaiting the train.

Visitors from New York come to Springfield, Mass., over the New Haven Road, and change there to the Connecticut River trains, which run north through the beautiful Connecticut Valley to Charlestown, New Hampshire. In the summer season White Mountain trains run without change from New York through Charlestown.

The trip takes six to eight hours from New York and from four to four and one-half hours from Boston.

Travelers from the West, if coming via the New York Central Railroad, generally continue to Springfield, Mass., over the Boston & Albany Division, or take the Fitchburg Railroad through the Hoosick Tunnel to Greenfield, Mass., the junction with the Connecticut River Railroad.

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